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"Reindeer at Mackenzie: A Selected Annotated Bibliography"

Northern Affairs Program

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1. Introduction

This annotated bibliography deals with the MacKenzie Delta reindeer (Rangifer tarandus tarandus L.) herd, presently the only commercial reindeer operation in Canada. The purpose of the present report is to document most of the background literature that has accrued over the nearly fifty-year history of the herd.

2. Background on the Reindeer Herd

For centuries the reindeer has played an important role in the economies and ecology of many northern Eurasian countries. In the late 1800's reindeer were imported to Alaska from Siberia (Lomen 1954, Scotter 1970a) and at least initially, the tended herds in Alaska flourished. Impressed by the early success of the Alaskan reindeer industry, the Canadian government in 1919 established a Royal Commission to investigate possibilities of reindeer husbandry in northern Canada. Envisioned was an opportunity to supplement the wildlife resources of the north and improve the poor economic conditions faced by native inhabitants (Rutherford et al. 1922). A preliminary survey was conducted between the Alaska/Yukon border and the Coppermine River in 1927 and 1928, and it was determined that excellent rangeland existed in the area east of the Mackenzie Delta, NWT (Porsild 1929). After an arduous six-year reindeer drive from Alaska, the Mackenzie Delta Reindeer Grazing Preserve (Figure 1) was put into operation in 1935 with the arrival of approximately 3,200 animals (Abrahamson 1963, Hill 1968).

From 1935 to about 1960 numerous unsuccessful attempts were made to break off from the government-owned reindeer herd smaller herds to be passed on to Inuit ownership. It is now believed that attempts failed for a combination of reasons including inefficient herding practices, over-harvesting of animals, overgrazing near settlements, and losses through disease, predation, poaching and straying animals (Scotter 1968, Stager & Denike 1972, Treude 1979). The "experiment" nonetheless demonstrated that herded reindeer could survive and multiply in the Mackenzie Delta area (Figure 2), and although the reindeer project was government-subsidized to a considerable extent during this period, distinct economic and social benefits for the regional population had developed (Hill 1967).

After about 1960, "open herding" techniques of herd management were adopted. Unlike the previous "closed herding" approach, the reindeer were allowed to run freely over the range with an annual organized roundup. The revised approach was far more labour-efficient (Hill 1967, Friesen & Nelson 1978). The herd was managed under contractual arrangements to several individuals until 1968 when the Canadian Wildlife Service was given interim control of the floundering operating consisting of only 2,700 animals (Stager & Denike 1972, Treude 1979). In 1974 the entire government reindeer holding was sold to the former chief herder, a native Inuit, who in turn sold it in 1977 to the present Inuit owner, William Nasogaluak. Employing sound herd management, the herd size has steadily increased in recent years to 13,000 in spring 1980 (Nasogaluak & Billingsley 1981), and about 16,000 in fall 1981 (Dickinson 1982). With access to new southern markets following the construction of the Dempster Highway, and the

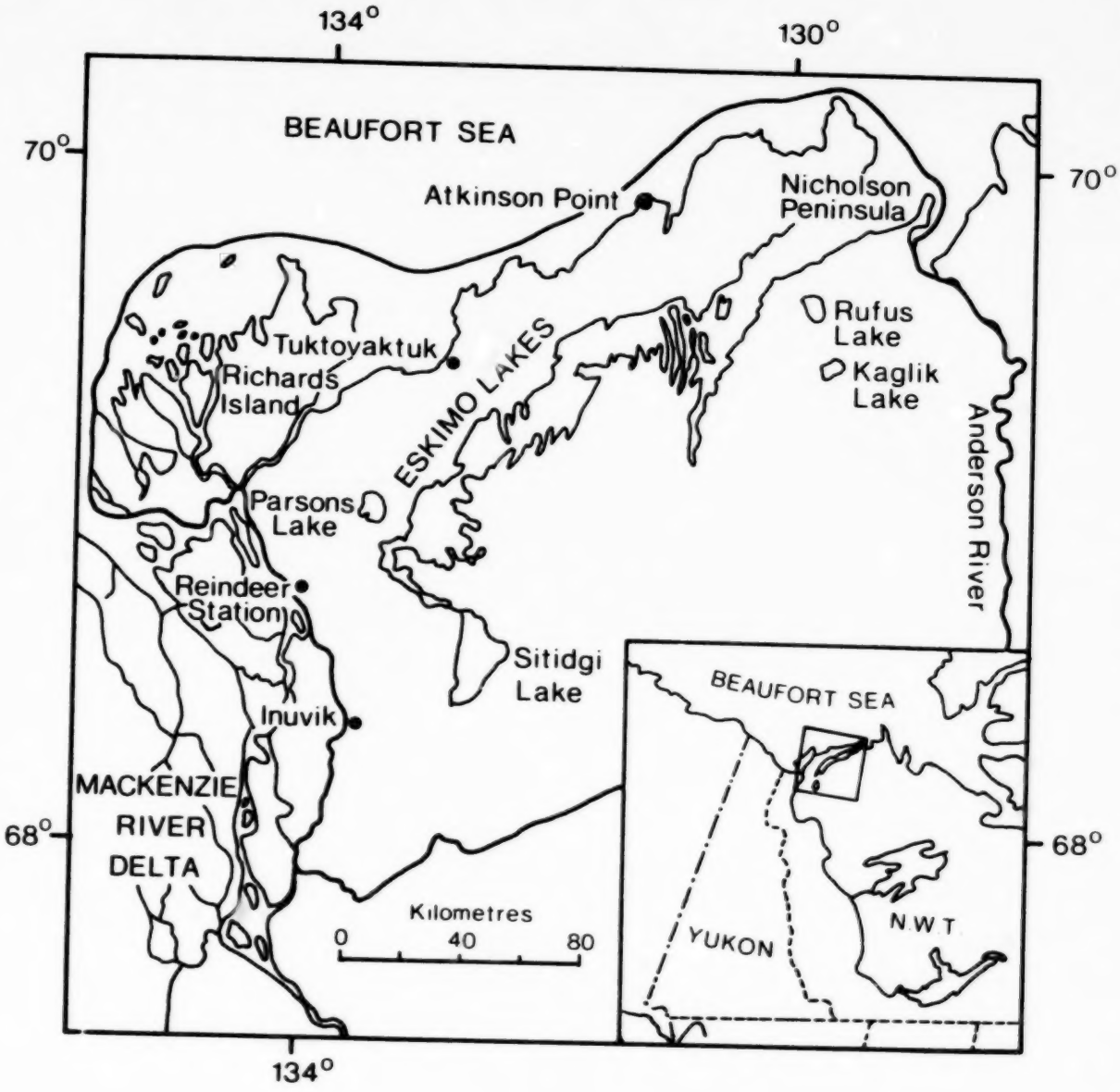

Fig. 1. Map of Reindeer Grazing Preserve east of the Mackenzie River Delta, NWT (after Hill 1967, 1968).

Fig. 2. Photographs of the reindeer operation in early years.

a. Portion of the reindeer herd on the beach, Reindeer Station, Mackenzie River; summer, 1936(?) (73PH320/ Archives, Prince of Wales Northern Heritage Centre, Yellowknife, NWT).

b. Reindeer roped to be sled deer at the summer corral, Richards Island; July 1937 (PA 101716/Public Archives Canada, Ottawa).

c. An Inuit-owned reindeer herd, native herd #2, at a Nicholson Island corral (PA 101288/Public Archives Canada).

d. Lapp herder and herd dog with a young deserted fawn, Richards Island; April 1936 (PA 121722/Public Archives Canada).

a
b
c
d

emergence of a lucrative cash crop, namely the sale of deer antlers to oriental markets as a component in medicines, Canadian Reindeer Ltd. has presently an optimistic economic forecast (Nasogaluak & Billingsley 1981).

Additional background on the herd has been given by many authors; see 'Historical Notes' in the Keyword Index (page 59).

3. Use of the Annotated Bibliography

It seemed timely with the present bright outlook for the reindeer operation that a summary of past literature dealing with the reindeer and the rangelands be made. This annotated listing consists of 119 entries, about half (63) of which deal directly with the herd. The other half provide background information important for future herd and rangeland management, and include entries on vegetation and flora, general physiography, terrain damage, other wildlife and other features of the broad area used as rangeland for the herd.

It is felt that the major proportion of published materials dealing with the reindeer herd are included here. Although some unpublished reports are given in this listing they are - because they have limited distributions and are often difficult to obtain - only incompletely represented.

The titles are indexed by principal author. Each entry consists of:

(1) an identification: Each publication is identified by the author's name(s), year of publication, title, source and number of pages.

(2) an annotation: The annotations are brief summaries of the publications. Most annotations have been written by the compilers. Where author abstracts or passages from the texts have been used, these are set off by quotation marks.

(3) a keyword list: The list of keywords is provided to help identify more specific subject areas, and may be used in conjunction with the subject keyword index of Section 5.

4. Annotated Bibliography

Abrahamson, G. 1963. Canada's reindeer. Can. Geogr. J. 66:188-193.

An illustrated article describing the seasonal operation of the reindeer industry in the Peserve in the early 1960's. At that time, the animals were herded to Richards Island for the summer months while spending the rest of the year on the ranges around Reindeer Depot (Reindeer Station). The problems encountered in encouraging natives to become "reindeer ranchers" are noted, e.g. ". . . it is an undesirable substitute for the precarious, but exciting, existence of the hunter or the settled, if dull, routine of the larger settlements such as Inuvik." The author states that while the project did not live up to early hopes for it, the country is well-suited for reindeer grazing and reindeer meat is a preferred food among Eskimos. Included are brief descriptions of the herders' day-to-day lives, the temperament of the reindeer, the annual slaughter, and uses for reindeer products - the meat for food, the hides and hair for warm clothing.

Keywords: historical notes - general operation, reindeer products and market, herd population dynamics

Ahti, T., G.W. Scotter and H. Vanska. 1973. Lichens of the Reindeer Preserve, Northwest Territories, Canada. The Bryologist 76(1):48-76.

Three hundred and fifty-six taxa of lichens are given in this listing of collections by Scotter in 1965 and 1966, from 40 locations throughout the Reindeer Preserve. Fifty taxa are reported as new to North America, a demonstration of how poorly the arctic Canadian lichen flora, especially the crustose lichens, is known. Driftwood and poorly-drained flats along the coasts were habitats for a number of lichens not previously noted from North America. For each taxa, voucher collection numbers, locations and habitat information are provided. The authors note that the majority of the lichen species recorded have a circumpolar, arctic to boreal range, although for many species it has not been proved. Although 356 species are reported, the total number of taxa in the area may be much higher, as evidenced by intensive studies in similar European areas.

Keywords: floristic notes - lichens, phytogeography

Anon. 1949. In the Court of the Stipendiary Magistrate for the Northwest Territories, Holden at Aklavik: The King vs James L. Jones. Court transcript of proceedings. Unpubl. MS (mimeo). 210 pp.

Detailed transcript of trial proceedings, January 17 to January 21, 1949 in which the defendent, J.L. Jones, was charged "under Section 3(b) of the Reindeer Protection Ordinance" for having, without lawful excuse, reindeer meat in his possession after a hunting trip. Testimonies considered the legal distinction between reindeer and caribou, and excellent information is included on the reindeer operation in 1949, herding methods,

the annual numbers of strays lost, grazing areas between 1935 and 1949, mixing of caribou with the reindeer herd and biological differences of reindeer and caribou.

Keywords: historical notes - general operation, caribou/reindeer conflicts, reindeer products and markets, herd population dynamics

Anon. 1974. Environmental program (1972-1974), Mackenzie Delta, NWT. Volume 3. Landform and Vegetation. F.F. Slaney & Co. Ltd., Vancouver, B.C. 55 pp. + appendices + maps.

A study of environment on portions of Richards Island and on the adjacent mainland at Swimming Point and immediately north of Parsons Lake, prepared for four sponsors (Imperial Oil Ltd., Gulf Oil Canada Ltd., Shell Canada Ltd., and Canadian Arctic Gas Study Ltd.) that had exploratory land-based oil rigs in these areas. Vegetation and landform is generally described, and it is noted that distribution of vegetation is dominated by drainage, while drainage is zonally determined by the texture of surficial material and locally by topography.

Vegetation mapping units are generally described, along with characteristic soils and permafrost conditions: Sedge-herb (Sh), Willow-sedge (Ws), Willow-herb(Wh), Meadow (Mw), Eriophorum tussock (Et), Alder (A), Medium willow (w), Black spruce (Bs), Dwarf shrub-heath (Ds), Xeric gravel (Xg), Patterned ground [Low centred polygons (Lcp), Low centred polygons with peat mounds (Lcpm)], High centred polygons (Hc), and undifferentiated complex mapping units and aquatic vegetation.

Appendixed data includes plant checklists, soils data, tables of vegetation cover-abundance, and ten approx. 1:60,000 scale maps of vegetation, and of terrain classification. Terrain classification mapping units include features such as beaded drainage, eroding thaw banks, pingoes, ice-wedge polygons, kettles and thermokarst, meltwater channels, peat, slopewash, etc.

The ten areas of interest (named Kumak Corridor, C-58, Taglu Corridor North, Taglu Corridor South, Swimming Point, F-36, P-53, N-10, K-09 and Parsons Corridor) are, in companion volumes of the limited-distribution report, described according to (I) Meteorology and Climate, (II) Hydrology, (III) Landform and Vegetation, (IV) Birds, (V) Mammals, (VI) Aquatic Resources, (VII) Environmental Quality.

Keywords: vegetation - ecology, vegetation-mapping (large-scale), physical geography, soils, permafrost-general

Anon. 1982a. Reindeer in Canada. Inuktitut Magazine 50 (May, 1982): 72-80.

A popular article, presented in both English and Eskimo (syllabics and roman orthography), describing the introductions of reindeer to northern Canada. Of the several attempts, only the Tuktoyaktuk herd met with any measure of success.

The hardships of the reindeer drive from Alaska are recounted. While during the period 1935-1969 the herd never totalled more than 9000, some 29,000 animals were slaughtered for human consumption.

The present operation of Canadian Reindeer Ltd. is described. Like other forms of farming, reindeer herding has drastically changed over the decades. Now skidoos and helicopters replace skis, and make herd control much easier. Remote sensing data from air photos and satellites are used to locate the best rangelands.

There is an annual round-up to count and ear-tag animals, remove horns, brand fawns, and select stock for breeding and slaughter. Twice yearly in winter months, selected reindeer are slaughtered for meat for northern and southern markets, hides for northern co-ops and horns for foreign markets.

Keywords: historical notes - trek from Alaska, historical notes - general operation, rangeland - general, reindeer products and markets, herd population dynamics.

Anon. 1982b. In the Quebec superior provincial court, district of Montreal, Gratton in Montreal: The Province of Quebec vs G. Hudon. Court transcript of judgement, 25 June, 1982. No. 500-36-044-8911. 7pp.

G Hudon, a restaurant owner, was charged with having sold 'big game' (caribou) thus contravening "Section 33 of the Quebec Wild-Life Conservation Act, RSQ, c C-61". In this text of the court judgment he was acquitted. The meat in question had been supplied by Canadian Reindeer (1978) Ltd., Tuktoyaktuk, NWT, and could not be considered big game because it was a commercial reindeer product and was acquired out-of-province. Testimonies deal with legal and taxonomic distinctions between caribou and reindeer, and the status of reindeer as 'big game'.

Keywords: reindeer products and markets, reindeer/caribou conflicts

Black, R.A., and L.C. Bliss. 1978. Recovery sequence of *Picea mariana* - *Vaccinium uliginosum* forests after burning near Inuvik, Northwest Territories, Canada. Can. J. Bot. 56:2020-2030.

"*Picea mariana* - *Vaccinium uliginosum* vegetation was sampled in a north-south transect near Inuvik, N.W.T., Canada. Four stages in the postfire recovery sequence were described. Little qualitative changes in vascular plants was found in the transect or with time since burning, although quantitative changes were found to exist. Contrary to vascular plant development, an orderly postfire succession of cryptogamic species was found. The postfire recovery sequence by comparison with other open boreal forest studies has a persistent shrub-dominated stage. Burning, with few exceptions, occurred within 100 years of examination along the transect. Objective analyses by Bray-Curtis ordination and reciprocal averaging ordination were used to analyse the vegetation data and proved useful in the data reduction and interpretation of results."

Keywords: vegetation-ecology, wildfire, floristic notes - vascular plants, floristic notes - lichens, vegetation-classification

Blaylock, D.M. 1980. Reindeer in North America. Rangelands 2(3):91-92.

Brief article describing the revitalization of the reindeer industry, particularly in Alaska, that is presently underway. The author notes that with modern technology and careful planning, the potential production and harvest of red meat from the North American tundra and boreal forest is many times the present production. Using 1975 figures, the author compares the number of reindeer in Canada (8000) to the number of caribou (574,000 plus 120,000 that migrate between Alaska and the Yukon) and indicates there is no imminent danger of encroachment by reindeer on the caribou, in terms of numbers.

Keywords: caribou/reindeer conflicts, rangeland-general

Burns, B.M. 1973. The climate of the Mackenzie Valley - Beaufort Sea. Vol. I. Environment Canada, Climatol. Stud. No. 24. 227 pp.

Tabled, graphed and mapped data giving a broad overview of climatic factors pertinent to the Mackenzie Valley - Beaufort Sea.

Keywords: macroclimate

Canada, Dept. of Energy, Mines and Resources. 1972. Terrain classification and sensitivity maps, Mackenzie Valley. Environmental-Social Program, Northern Pipelines. NTS mapsheets 107B, 107C, 107D, 107E. 1:250,000.

Derived maps illustrating land capability and performance, and sensitivity to environmental disturbance. Information is provided on surficial geology and bedrock, and an accompanying legend gives information on local descriptions, permafrost and ground ice conditions, drainage characteristics, hazards, and evaluations of terrain units as sources of construction materials.

Keywords: surficial geology, permafrost - general, terrain disturbance, sensitive sites, physical geography

Canada, Dept. Environment 1973. Atlas of wildlife habitat inventory maps for Environmental-Social Program, Northern Pipelines. Can. Wildl. Serv., Ottawa. 7 volumes.

Keywords: wildlife, caribou/reindeer conflicts, rangeland-general

Canada, Dept. Environment. 1974a. Vegetation types of the Lower Mackenzie and Yukon corridors. Environmental-Social Program, Northern

Pipelines. Forest Management Institute, Can. For. Serv., Ottawa. 3 mapsheets. 1:125,000 scale.

Mapped vegetation units for the western third of the Reindeer Preserve were interpreted from 1:50,000 to 1:70,000 aerial photographs (taken 1970 to 1972) with field checks during 1973. Seven major mapping types were recognized; high shrub, low shrub, low shrub wetlands, moss lichen, monocotyledonic wetlands, monocotyledonic, and tundra pond fields. Twenty sub-types were also mapped, and height, species and canopy density classes were indicated in the legends for forested areas.

Keywords: vegetation-mapping (regional), vegetation-classification

Canada, Dept. Environment. 1974b. Maps showing vegetation types of the lower Mackenzie and Yukon corridors. Environmental-Social Program, Northern Pipelines. Forest Management Institute, Can. For. Serv., Ottawa. 11 mapsheets.

Colour-coded 1:500,000 maps of "vegetation-type aggregates" in the Old Crow, North Shore, Inuvik and Tuktoyaktuk regions. Mapped features include: 1) high and low shrubs, alluvial sites, fair drainage, 2) high and low shrubs, upland sites, good drainage, 3) high shrub, grass and sedge, upland fans and eroded sites, fair to excessive drainage 4) low shrub, moss, lichen and grass, variable to flat terrain, poor to fair drainage, 5) dwarf shrub, moss, lichen and grass, exposed high elevations, excessive drainage, 6) grass, sedge and low shrub, lowland flat sites, fair to poor drainage, 7) sedge, grass and moss, flat to variable terrain, wet site, 8) water, 9) burn, 10) rock, open or improved land.

Keywords: vegetation - mapping (regional), vegetation - classification, wildfire

Canada, Dept. Environment. 1975. Vegetation types of the lower Mackenzie and Yukon corridor. Environmental-Social Program, Northern Pipelines. Forest Manamagenet Institute, Can. For. Serv., Ottawa. Rep. No. 74-40. 73 pp. and appendices.

Describes vegetation classification and mapping for a proposed pipeline corridor in the Old Crow, North Shore, Inuvik and Tuktoyaktuk regions. Air photo interpretation of available 1:60,000 photographs and field reconnaissance were conducted, and seven major vegetation classes subdivided into one to five subclasses were identified and mapped at 1:125,000 and 1:500,000. Some statistical summaries of percent occurrence of the vegetation types are provided. Tree cover, high shrub, low shrub and ground vegetation characteristics of each vegetation subclass are described, and observations on permafrost and other special conditions associated with them are made. Recommendations relating to pipeline construction and additional research are given.

Keywords: vegetation - mapping (regional), vegetation - classification

Canada, Dept. Indian & Northern Affairs. 1976. Mackenzie Delta (107C), Stanton (107D), Aklavik (107B), Crossley Lakes (107A). Land Use Information Series Mapsheets. 1:250,000 scale.

The Reindeer Grazing Reserve is located on these mapsheets and areas considered as critical fawning grounds and winter range for the reindeer at the time of map preparation are indicated. Other land use components of the rangeland are mapped and briefly described in the legend, including critical waterfowl and other wildlife habitats, hunting, trapping and fishing areas, game management boundaries, historical and archeological sites, IBP-CT reserve sites and other features.

Keywords: alternative land use, caribou/reindeer conflicts, sensitive sites

Clarke, C.H.D. 1942. Report on development of the reindeer industry - Mackenzie District, N.W.T. Lands, Parks and Forests Br., Dept. Mines & Resources. Mimeo unpubl. report. 17 pp.

Narrative report by the author of a trip made to the Reindeer Station to observe the operation during July to October, 1942. In 1942, the herd numbered 9380 animals, tripled in seven years from its size of 2960 head in 1935, and major concerns were the methods by which native herds would be established, used by owners, sold to new owners, sold to local whites, etc. The uses and potentials for meat and hides and potential growth of the industry to other parts of the Canadian arctic are discussed.

Keywords: historical notes - general operation, herd population dynamics, reindeer products and markets, rangeland-general

Cody, W.J. 1963. Reindeer range survey. 1957 and 1963. Plant Res. Inst., Can. Dept. Agric., Ottawa. Unpubl. Rep. 16 pp.

A first botanical survey was made of portions of the Reindeer Preserve in 1957, following a period from 1952 to 1956 when a number of animals died or had to be destroyed because of bone breakage believed due to a dietary deficiency. A second survey was made six years later to ascertain if any changes had taken place. While no significant changes in the range were noted, overgrazing was observed in several situations on both summer and winter ranges, especially in holding areas adjacent to corrals and herders' living quarters. At Toker Point, the area in the immediate vincinity of the camp is described as "badly trampled and overgrazed" particularily obvious being the stripped branches of low willows. Summer Island, at the north end of Richards Island, "has definitely been overgrazed and it is recommended that it not be used again for grazing until the vegetation has had an opportunity to recover". At a winter corral 7 km southeast of Urquart Lake, the "surrounding country appeared to have a good lichen cover among the open stands of Picea" however, "in the immediate vicinity of the corral considerable trampling and tearing apart of the lichens was noted. At Reindeer Station, the tundra rangeland had low cover by reindeer lichens

and white spruce (Picea glauca) had been rubbed and the lower branches eaten off to the height of the deer. At the east side of the East Channel Mackenzie River near Icy Creek, the "lichen patches had been badly torn apart, fragmented and pawed, but a few years will probably be sufficient for them to recover".

In 1954 large areas of productive winter range were destroyed by fire, and the vegetation recovery was examined at Burnt Lake (68°52'N, 132°05'W) by the author in 1957 and 1963. Shrubs, grasses and forbs were recovering well, but lichens have not reappeared. The ground had become very hummocky as ice receded under areas where there was little insulating humus or vegetation.

General notes are given on herd condition, including the possible beneficial effects of the newly-instituted "open herding" technique, and the influence of biting insects on the general health of the herd. It is suggested the bone-breakage problem might have been due to continual harrassment by biting flies in summer and the effects of close-herding.

A line map outlines broad areas of summer, spring and fall, and winter ranges utilizing the entire Grazing Preserve. The future of the operation is briefly considered with the author summarizing that "although actual carrying capacity of summer and winter ranges cannot readily be estimated there is certainly room for many more deer in the area than are presently being grazed there without any depletion of the range."

Keywords: overgrazing, vegetation-ecology, wildlife, rangeland-rotational use, sensitive sites, floristic notes - vascular plants, rangeland-general, disease and parasites

Cody, W.J. 1965a. Plants of the Mackenzie River Delta and Reindeer Grazing Preserve. Canada Dept. Agric., Plant Res. Inst. (offset) 56 pp.

Four hundred and twenty taxa of vascular plants are given in an annotated list for the Delta and Grazing Preserve, based mainly on the author's collections in 1953, 1957 and 1963. Of the total of 55 families represented, the larger ones are given as: Cyperaceae (52 taxa), Compositae (45 taxa), Gramineae (41 taxa), Cruciferae (26 taxa), and Caryophyllaceae (24 taxa). These five families account for 45% of the reported taxa.

Distributionally, circumpolar or nearly circumpolar species account for almost half of the plants, about one sixth of the flora is broad ranging American species, and another sixth of the flora is transberingian. Small portions of the flora are centred in Alaska and the Yukon or are amphi-Atlantic, North American arctic-alpine, introduced weeds or endemic.

The author provides, in addition to the phylogenetic listing with habitat notes, background information on previous botanical collections in the area, the physical geography, the major vegetation zones and some brief

notes on grazing and overgrazing by the reindeer. Grasses, sedges and willows which form the largest part of the reindeers' summer diet recover fairly quickly from being grazed, provided they are not overutilized as is the case around some holding areas and corrals, or on "Summer Island" a small islet at the northeast tip of Richards Island.

Keywords: floristic notes - vascular plants, phytogeography, vegetation - ecology, overgrazing

Cody, W.J. 1965b. New plant records from northwestern Mackenzie District, N.W.T. Can. Field-Nat. 79:98-106.

A list of 63 notable vascular plant collections by the author in 1957 and 1963, with location (Mackenzie Delta and the Reindeer Preserve), and habitat information.

Keywords: floristic notes - vascular plants, vegetation - ecology, phytogeography

Cody, W.J. 1979. Vascular plants of restricted range in the continental Northwest Territories, Canada. Nat. Mus. Nat. Sci., Ottawa. Syllogeus No. 23. 57 pp.

A description of 530 species which have restricted distributions within the continental Northwest Territories, and selected bibliographic references to substantiate these ranges. Includes a few species with ranges restricted within, or including portions of the Reindeer Preserve, such as Puccinellia andersonii Swallen, Potentilla pulchella R. Br., and Antennaria crymophila Porsild.

Keywords: floristic notes - vascular plants, phytogeography

Corns, I.G.W. 1974. Arctic plant communities east of the Mackenzie Delta. Can. J. Bot. 52:1731-1745.

A quadrat sampling approach was used to describe vegetation communities occurring at five locations on the northern half of the Preserve: Tununuk Point at the south end of Richards Island, a few km north of Reindeer Station, near the townsite of Tuktoyaktuk, at the southeast end of Eskimo Lake, and at Atkinson Point. On the basis of 64 sampled and 12 described stands, five main types (Tall Shrub-Herb, Medium Shrub (adler), Low Shrub-Heath, Herb-Low Shrub-Heath, and Herb) and 11 subgroups were classified and distinguished based on physiognomy and floristic similarity. Classification was aided by two-dimensional ordination (Bray & Curtis approach) of the cover data. Percentage cover of the five major community types was determined on three alternative 1:20,000 black and white airphotos for each of the five locations using a point-grid overlay, and the results are tabled. An appendix provides a simple hierarchic key to the types and subgroups identified, and a table lists covervalues for the 46 most abundant taxa encountered in the survey, and

summarizes percentage cover by mosses, lichens, dead material and bare mineral soil.

Keywords: vegetation - classification, vegetation - ecology, floristic notes - vascular plants

Crampton, C.B. 1977. A study of the dynamics of hummocky microrelief in the Canadian north. Can. J. Earth Sci. 14:639-649.

Observations of hummocky and mound microrelief in northern Canada, including studies near Inuvik. Morphology of these features and their dynamics, and susceptibility to disturbance are discussed.

Keywords: soils, permafrost - general, terrain disturbance

Crerar, T.A. and Bonnycastle, R.H.G. 1936. Canada's reindeer experiment. Trans. N. Amer. Wildl. Conf. 1:424-427.

Brief article documenting the Department of Interior's plan for establishing an experimental reindeer industry at the Mackenzie Delta, including the Royal Commission investigation and the two year (1926-1928) reconnaissance of reindeer pastureland conducted by A.E. Porsild that led to the purchase of Alaskan reindeer in 1929. Some comments on the success of the first year of operation (1935) are provided.

Keywords: historical notes - establishment of herd

Dickinson, T. 1982. Reflections in an orbiting eye. Equinox 1(3):58-71.

Popular article deals with LANDSAT observations of Canada, and practical applications of the technology. A brief description is included on ongoing studies to determine areas of best-quality reindeer rangeland on the Tuktoyaktuk Peninsula using LANDSAT imagery and aerial photograph.

Keywords: rangeland - general, remote sensing.

Evans, A.R. 1933. Meat - a story of the four-year trek of the Canadian Government reindeer herd. The Beaver, Outfit 264(4):026-28, 64;265(1):-24-27; 265(2):14-17; 265(3):22-25.

A fictional account of events occurring during the difficult transport of 3000 reindeer from western Alaska to the Mackenzie Delta area. While the characters are fictitious, the incidents described are based upon reports received from Andrew Bahr, the Laplander in charge of the herd during the trek.

Keywords: historical notes - trek from Alaska

Freedman, W. and T.C. Hutchinson. 1976. Physical and biological effects of experimental crude oil spills on Low Arctic tundra in the vicinity of Tuktoyaktuk, N.W.T. Can. J. Bot. 54:2219-2230.

"Data are presented on the effects of simulated crude oil spills on two Low Arctic terrestrial tundra plant communities near Tuktoyaktuk, Northwest Territories. Spills of fresh, unweathered crude oil had a general herbicide effect, resulting in rapid damage to and subsequent death of all aboveground actively growing foliage coming in contact with the oil. Most species were defoliated. Mosses and lichens were especially susceptible and killed. However, within several weeks of the summer oil spillages, a limited number of relatively tolerant vascular plant species began to develop regrowth shoots.

Summer spills were markedly more damaging than were equivalent spills made in winter. No increases were seen in active layer depth from spills made in summer. However, winter spills on one of the two sites did show consistent and statistically significant ($P>0.01$) increases in depth of thaw. Examination of several key energy budget parameters at these field sites indicated consistently lower albedos and evapotranspiration and consistently higher soil surface temperatures and soil heat flux at all oil spill sites, relative to their controls. However, except for a winter spill on one site, the recorded differences were not sufficiently large in magnitude to produce significant increases in active layer thaw depths."

The work is based on Freedman's (1975) M.Sc. thesis of the same title, at Univ. Toronto, Toronto, Ontario.

Keywords: terrain disturbance, vegetation-energy budget, microclimate

Friesen, B.F. and J.G. Nelson. 1978. An overview of the economic potential of wildlife and fish resources in the Canadian arctic. Pages 163-180 in Northern Transitions, Vol. 2. Second Nat. Worksh. on People, Resources and the Environment North of 60°, Can. Arctic Res. Comm., Ottawa.

A review paper on the knowledge of fish and wildlife resources in the Canadian arctic, intended to "provide discussion about future uses of these resources and the distribution of benefits and costs among Inuit and southern Canadians." The technical and biological feasibility of reindeer ranching in the north has been proven by the Mackenzie Delta herd, and although past economic problems are noted, with less intensive "open herding", larger-scale operations, and better management, reindeer herding may in the future be profitable. Drawing on Scotter's (1969) remarks, the authors indicate that caribou game-ranching could increase wild caribou yields and be culturally more acceptable than intensive reindeer herding.

Keywords: wildlife, rangeland-general, reindeer products and markets

Gill, D.E. 1971. Vegetation and environment in the Mackenzie River Delta: A study in subarctic ecology. Unpubl. Ph.D. thesis, Dept. of Geography, Univ. of British Columbia. 694 pp. (+ map).

Vegetation, soils, microclimate and permafrost investigations on the low alluvial floodplains near Reindeer Station. Major plant communities recognized included nine seral associations, and one climax ecosystem: Equisetum, Salix-Equisetum, Salix-Alnus, Populus, Salix, Salix-Carex, Carex, Arctophila, Picea. A vegetation map at a scale of 1:16,800 is presented for the study area. While the ecosystems described do not represent acceptable reindeer rangeland, the study's proximity to the Preserve is notable. Some mention is made of locally-occurring tundra communities similar to those occurring on the Preserve (e.g. pp. 255-267).

The study was intended to "describe and analyze the interrelations of vegetation and environment in the east-central sector of the Mackenzie River Delta, Northwest Territories. It traces the sequence and function of the allogenic events which create varying habitat systems and determines whether environmental modification, once initiated on terra nova is directional - in either a physical or floristic expression.

In determining the sequence and influence of physical environmental factors, the following parameters were measured, employing standard instruments and field investigation techniques: micro-relief; depth, areal extent, and duration of flooding; thickness, areal extent, and particle size distribution of annual deposits of alluvium; magnitude and significance of erosion; patterns of microclimatic variation (including air temperature and humidity, evaporativity, precipitation, wind speed, solar radiation, and net radiation); lake and channel temperatures; soil pH, moisture (hygrotope class), and temperature; development of varying active layer depths; and freezeback of the active layer.

To analyze the vegetation of the study area, the phytosociologic methods of the Braun-Blanquet (Zurich-Montpellier) school were applied. Nine seral associations and the climax ecosystem were studied; each was fitted into a successional category. Plant succession was analyzed by reconstructing the course of vegetative development from pioneer to climax community with the aid of successional transects.

Results of this study indicate that environmental and floristic changes in the Mackenzie Delta are directional - that given the formation of new ground, such as on the slipoff slope of a shifting channel, ecologic variation will follow a predictable direction. As the seral sequence advances, autogenic influences become dominant over the allogenic initiators until in the climax association, relatively steady-state conditions of environment and vegetation are attained."

Keywords: vegetation-classification, vegetation-ecology, soils, microclimate, permafrost-general, floristic notes-general, vegetation-mapping (large-scale), physical geography, sensitive sites.

Haag, R.W. 1973. Energy budget changes following surface disturbance to two northern vegetation types. in Bliss, L.C. (ed.) Botanical studies of disturbed sites in sub-arctic and arctic regions. Environmental-Social Program, Northern Pipelines. Report No. 73-43:6-26.

Measurements were made at two sites - a spruce/larch forest at Norman Wells and an upland dwarf shrub-heath tundra near Tuktoyaktuk - of albedo and long-wave radiation, latent heat loss, soil heat flux and thermal regime and active layer depth. An undisturbed control area at the Tuktoyaktuk site was compared to disturbed areas: a 1970 winter road, a controlled burn and an oil spill plot.

Keywords: terrain disturbance, microclimate, soils, vegetation - energy budget, wildfire

Haag, R.W. 1974. Nutrient limitations to plant production in two tundra communities. Can. J. Bot. 52:103-116.

Nitrogen and phosphorus were investigated as limiting factors to primary production in two sites - a lowland wet sedge meadow and an upland birch - willow-heath community - near Tuktoyaktuk, N.W.T.

"Response to nitrogen fertilization in both communities, including increased protein content and dry weight production, indicates that nitrogen supply limits production in both soils. In the upland community, phosphorus supply does not limit production, but in the lowland sedge meadow, dilution of the soil solution may decrease phosphorus availability

Nitrogen, if available, can be taken up and metabolized into organic compounds despite low soil temperatures. Phosphorus metabolism may be directly limited by low soil temperatures and low available nitrogen levels.

Low soil temperature exerts an indirect limitation on plant production through limitation of organic matter decomposition and microbial nitrification, thus limiting the rate of nitrogen cycling.

The importance of a low nutrient regime in the Arctic may be seen in the widespread occurrence of xeromorphic characters in many taxa, which thus require minimal mineral nutrition to best use their photsynthetic capacity. The low nutrient regime may partially explain the high proportion of perennial plants in the Arctic, since these species can accumulate a nutrient pool over time from a deficient environment."

Keywords: vegetation-fertility/chemistry, soils, vegetation-energy budget, microclimate

Haag, R.W. and L.C. Bliss. 1974. Energy budget changes following surface disturbance to upland tundra. J. Appl. Ecol. 11:355-374.

"The effects of three types of surface disturbance (winter road, fire, and oil spill) on the radiant energy budget of upland low shrub-heath tundra were investigated. All disturbances to vegetation or the soil surface resulted in an albedo reduction, which led to a direct increase in net radiation. Despite the increase in net radiation, latent heat loss decreased on all disturbances due to vegetation removal and loss of access to sub-surface soil moisture. Latent heat loss from disturbed surfaces was dependent on surface moisture levels. The decrease in latent heat loss upward resulted in an increase in soil heat flux, soil temperatures, and depth of the active layer.

Undisturbed peat with high water content provides good thermal insulation on the surface and acts to decrease rate of soil thaw. Where peat was removed, mineral soil thawed at a rapid, nearly constant rate, and thaw depth exceeded control values by over 50% at the end of the summer. Such an increase can in turn lead to surface subsidence and, a further increase in resistance to latent heat loss resulting from thicker boundary layer conditions over the disturbed surface.

Re-seeding acts to increase rate of albedo recovery following disturbance. However, if litter is not replaced, increased plant cover has little effect on active layer depth during the first three years of re-growth."

Keywords: vegetation-energy budget, soils, microclimate, terrain disturbance

Hadwen, I.S. 1939. A visit to the Mackenzie River Delta. Ontario Res. Foundation, Bulletin 6(12):1-4 (Dec., 1939)

"Report of a visit made at the request of the Northwest Territories Council, in the summer of 1939, to inspect the reindeer herd. Gives brief notes on diseases, parasites, increase and fertility of the herds, carrying capacity of the ranges, and the Eskimo herders." [6438 in Arctic Bibliography (1953) 1:974].

Keywords: rangeland-general, rangeland-carrying capacity, historical notes-general operation, herd population dynamics, disease and parasites

Hawley, V.D. 1970. Caribou penetrations of the Reindeer Grazing Reserve, N.W.T.; Winter, 1969-70. Can. Wildl. Serv., Ottawa. Unpubl. Report. 16 pp.

During two periods of study (26 Nov. and 1 Dec., 1981 and 8 and 11 March 1970), reconnaissance flights covered 18,963 and 20,441 sq. km areas respectively, and 1,110 and 526 caribou were seen. Before about 1964, caribou were rarely reported as migrants onto the Reindeer Grazing Reserve, however, estimates from the 1969-70 survey were that there were

approximately 1500 caribou on the Reserve in March and probably about twice that number in the fall.

The report recommends 1) continued detailed surveys in the southeastern areas of the Reserve to determine if a trend is for an increasingly westward extension of the Bluenose caribou herd's winter range, and 2) detailed information on the movements and status of the Bluenose herd so that information from Reserve surveys would be more meaningful.

Keywords: caribou/reindeer conflicts

Hernandez, H. 1973. Natural plant recolonization of surficial disturbances, Tuktoyaktuk Peninsula Region, Northwest Territories. Can. J. Bot. 51:2177-2196.

"Seismic lines or winter roads were sampled where they passed through three different plant communities in the Mackenzie Delta and through four of the major tundra communities in the Tuktoyaktuk Peninsula. Winter seismic lines have been less detrimental than summer lines for all communities examined. Although winter roads through upland areas remove most of the vegetation cover, the peat layer usually remains intact and soil energy budgets are relatively little affected. Wetland sedge meadows are highly susceptible to summer disturbance but least affected by winter operations. Winter-disturbed forested and tall shrub communities recover faster initially than similarly disturbed upland tundra communities.

Eriophorum vaginatum and Carex bigelowii appeared to be stimulated by disturbances which did not eliminate them, with Eriophorum often flowering more abundantly in disturbed areas. This probably results from warmer soils and greater nutrient uptake.

Summer seismic lines (1965), originally bladed to permafrost, resulted in exposure of mineral soil and thus led to secondary succession in tundra communities. Arctagrostis latifolia, Calamagrostis canadensis, Poa arctica, and Luzula confusa are the most typical and abundant pioneers of upland mesic sites. Wet sites are colonized predominatly by Arctophila fulva and Carex aquatilis. Once established, these species expanded rhizomatously. Six years after exposure of mineral soil, plant cover was usually 30 to 50%.

Thaw was generally increased 80 to 100% where mineral soil was exposed, 30 to 50% if the peat remained intact, and 10% if plant cover was little altered. Subsurface ice has occasionally been exposed, resulting in thermokarst subsidence. Water erosion has not been a factor, probably because of the low precipitation in the region."

Keywords: terrain disturbance, vegetation-ecology, floristic notes-general, soils, microclimate

Hernandez, H. 1974. Possible effects on vegetation of the proposed gas pipeline from Prudhoe Bay, Alaska and the Mackenzie Delta, to Alberta. Pages 37-68 in Research Reports, Vol. IV of Environmental impact assessment of the portion of the Mackenzie gas pipeline from Alaska to Alberta. Environment Protection Board, Winnipeg, Man.

Report generally describes regional vegetation along proposed route of a northern gas pipeline, discusses the role and occurrence of fire in northern forested and tundra plant communities, and assesses the possible effects on the terrestrial vegetation from construction and operation of the proposed pipeline. The vegetation of the Tuktoyaktuk Peninsula area is described as low arctic tundra (herbaceous coastal tundra, low shrub-heath tundra).

Keywords: terrain disturbance, vegetation - mapping (regional), vegetation - classification, wildfire

Hill, R.M. 1967. Mackenzie reindeer operations. North. Coord. and Res. Centre, Dept. Indian Affairs and North. Develop., Rep NCRC 67-1. 161 pp.

A comprehensive description of the Mackenzie reindeer industry after its first three decades of operation, including historical, biological and economic aspects. In 1966-67 the reindeer were managed by a contractor, overseen by the federal government. A number of recently introduced modernizations are evaluated: aircraft were introduced for regular reconnaissance patrols and for moving herders between camps and Reindeer Station; winter travel with the herd was improved by building up a number of good dog sleds; freighter canoes were purchased for summer travel; homes at Reindeer Station were reinsulated; a high frequency radio network with a base at Reindeer Station and mobile transceivers for field teams was put into operation; a radical change in herding methods with the adaptation of extensive "open-herding" was begun, and all of the reindeer were merged into a single herd where previously there had been three (one in the Richards Island-Reindeer Station area, one in the Cape Dalhousie-Eskimo Lakes area, and one around Tuktoyaktuk).

The report is divided into seven chapters dealing with various aspects of the 1967 operation, and an eighth considering future possibilities.

Chapter I deals with reindeer products. Reindeer meat, the major product, readily competes locally with beef and other domestic meats

especially because it can be sold at lower prices, and a southern specialty market could be expanded considerably, it is believed. Uses for nonedible byproducts (skins, antlers and hooves, offal) are reviewed, and possibilities exist for live sales to establish northern reindeer herds elsewhere and to supply farms and zoos in the south with healthy stock. Markets for reindeer products are considered in Chapter II including the early markets, pricing categories, market area breakdowns, present and future sales potential, and a proposal for a future marketing program, including organized promotion of reindeer products. In Chapter III, range management is considered. Physiography and vegetation of the range is generally described, noting summer, spring, fall and winter rangelands, and the major forages. The slow growth of winter lichen forage, its susceptibility to fire, trampling and overgrazing, and its importance to the subsistence winter diet of reindeer makes the winter range of particular importance. Summer range appears to stand up well under heavy grazing, in some areas fodder cover actually increasing due possibly to the "tilling" effect of reindeer hooves. Past estimates of grazing capacity are tabled and compared to similar rangelands in Alaska, Sweden and Norway, although "because of the many possible variations in herding patterns, weather conditions, and the unknowns of reindeer browsing, it is very difficult to make accurate estimates of reindeer grazing capacity". Optimum utilization of the rangeland, based on a full knowledge of the available fodder and reindeer browsing habits is required and a future rotational grazing plan for the Preserve is called for.

Range damage by fire, especially the 2100 sq km fire at the Kugaluk River mouth in 1954, and by human activity on the tundra (e.g. vehicle damage by oil exploration companies, seismic line construction) must be minimized, so that large tracts of productive range are not lost in the future.

Chapter IV, herd management, includes information on reindeer physiology, herding methods, herd size, herd composition, seasonal movements, roundups, natural losses and negative influences, and production yield. Slaughter and packing is covered in Chapter V, and possibilities for physiological, range and economic research are described in Chapter VI. Chapter VII deals with economics of the operation, tallying income and expenses for the four-year period 1963-1967, and providing a ten-year projected model for income and expenses for a self-supporting operation. The last chapter (VIII) considers the future of the reindeer industry at the Mackenzie Delta. Reindeer ranching is uniquely northern and while the biological success of the enterprise is proven, the author notes the difficulties of developing any basic industry in the north. Future ownerships of the herd is considered under government, private, or contractual arrangements, and a number of "general considerations" for the future are listed. It is concluded that "a thriving reindeer industry in the Mackenzie Delta area will be an important step towards the development of northern Canada."

Keywords: historical notes-general operation, reindeer products and markets, rangeland-general, rangeland-carrying capacity, herd population dynamics, fawn growth and development, overgrazing effects, disease and parasites, caribou/reindeer conflicts

Hill, R.M. 1968. The Canadian reindeer project. Polar Rec. 14(88):21-24.

A brief review article describing the location of the Reindeer Preserve, the general vegetational cover of the spring and fall, winter and summer rangelands; the open-herding method employed (whereby the animals are loosely herded to the coast in summer, inland in winter by aircraft and ground teams), and the economics of the industry. Increases in productivity through selective slaughters, slaugterhouse and equipment improvements, and better herd management are suggested, since "a successful reindeer industry in the Mackenzie District would unquestionably be of great benefit to the regional economy".

Keywords: rangeland-general, reindeer products and markets

Holmen, K. and G.W. Scotter. 1971. Mosses of the Reindeer Preserve, Northwest Territories, Canada. Lindbergia 1-2:34-56.

One hundred and seventy-nine taxa of mosses are reported based on collections at 40 locations throughout the Reindeer Preserve by Scotter in 1965 and 1966. "Some of the records provide new information on the geographic distribution of bryophytes in arctic and subarctic North America and others represent collections of species which are widely distributed in the Northern Hemisphere". For each taxa, collection numbers and locations are cited, along with brief distributional and habitat notes. The Preserve has a moss flora that is rich in species, particularily when the small number of habitats and little variation in climate are considered.

Keywords: floristic notes - mosses, phytogeography

Hulten, E. 1968. Flora of Alaska and neighbouring territories. Stanford Univ. Press. 1008 pp.

Comprehensive flora of Alaska, but including distributional maps that cover the majority of vascular plants found in the Reindeer Preserve, N.W.T. Collection locations, habitat notes and taxonomic keys are provided for all taxa.

Keywords: floristic notes - vascular plants, phytogeography

Hutchinson, T.C. and W. Freedman. 1976. The impact of crude oil spills on arctic and subarctic vegetation. in Proc. Circumpolar Conf. on Northern Ecology; Nat. Res. Council & Can. Nat. Comm., Scientific. Comm. on Problems of Environment. pp. I175-I182.

Simulated oil spills on arctic communities near Tuktoyaktuk and Inuvik allowed studies of short-term damage and long-term recovery (4 years) of

vegetation. Lichens and mosses were largely eliminated, while vascular species differed markedly in their ability to survive damage.

Keywords: terrain disturbance, vegetation - ecology, soils

Hutchinson, T.C., J.A. Hellebust and M. Telford. 1976. Oil spill effects on vegetation and soil microfauna at Norman Wells and Tuktoyaktuk, NWT. Environmental-Social Program, Northern Pipelines. Report No. 74-75-83. 143 pp.

Experimental oil spills of varying magnitude made both during summer and winter were conducted at taiga and tundra sites in arctic Canada. Tundra vegetation was affected generally less severely than boreal-taiga because of the presence of a few very "resistant" species: Salix glauca, Eriophorum vaginatum and the moss Polytrichum juniperinum. All lichens, however, were wiped out. Winter spills had a less severe effect than summer spills due to the absence of actively-growing foliage at the time of the spill. Oil spills severely reduced reproductive ability so that few species flowered or fruited during the three years after the spills. Energy budgets at spill sites were altered, with particular changes to albedo and soil temperatures. Soil arthropods were destroyed at spill sites and may require ten years to become reestablished. Effects of oil spills on aquatic vegetation are also described and discussed.

Keywords: terrain disturbance, vegetation - ecology, soils, vegetation - energy budget

Inglis, J.T. 1971. Reindeer range relationships in the Sitidgi Lake area, N.W.T. - Preliminary report. Can. Wildl. Serv., Edmonton, Alta. Unpubl. File Report. 9 pp.

A progress report on a study of food habits, feeding behaviour and movements of the reindeer herd in the Sitidgi Lake area during December 1968 to September 1970. Ground lichens, especially selected Cladina and Cetraria spp., account for 75% of the winter diet. Arboreal lichens are not generally abundant enough to contribute significantly to diet, and the importance of Eriophorum vaginatum, although often abundant, is not known. Woody plants are frequently grazed. Lichens tend to be grazed from hummock tops, and preferred areas for cratering are open exposed slopes and polygon crests where lichens are more abundant.

Overgrazing was not noted following the first winter's use of an area, but did occur during the second winter. Depth and density of snow cover varies from year to year and may in some cases protect an area from repeated grazing. The herd mostly grazes as a unit on open ground but tends to scatter and eventually stray among trees. Movement "follows paths of least resistance" along small topographical breaks, creeks, cut banks and slopes, and this makes direction control difficult for herders. Vegetation was examined and described at the ground sites, but results are not tabled here, to develop seven map types (i) white spruce, (ii) black

spruce, (iii) black-white spruce (iv) shrub-lichen, (v) polygons, (vi) drainage networks, (vii) burns, although the winter range around Sitidgi Lake is described as "a mosaic of vegetation types".

Keywords: overgrazing, vegetation-classification, rangeland-general

Inglis, J.T. 1975a. Vegetation and reindeer-range relationships in the forest-tundra transition zone, Sitidgi Lake area, N.W.T. M.Sc. thesis, Dept. Biology, Carleton Univ., Ottawa. 185 pp.

"Vegetation and reindeer-range relationships in the forest-tundra transition zone of the Mackenzie Delta region, N.W.T., were studied from 1968 to 1970.

Classification and ordination approaches were used in the analysis of quantitative data, obtained from representative plant communities in the Sitidgi Lake study area. Seven vegetation types were defined from the results of a hierarchical group analysis, and were compared with types described from arctic, alpine and boreal formations. Some types are very similar in vegetation structure and floristic composition and, in future winter range mapping, a broad concept of shrub - heath - lichen and spruce - lichen - moss communities may be required.

Principal components analysis was used for stand ordination, and the results demonstrated an almost continuous variation in community composition. Two major trends in the vegetation were determined. The first leads to the formation of a climax, closed canopy Picea glauca - Hylocomium splendens association in response to improved soil drainage, favourable microclimate, and the absence of disturbance. The second results in the formation of a Picea mariana - Cladonia mitis association developed in response to peat accumulation in depressions, soil moisture conditions, or forest fire.

Open exposed areas, dominated by shrub - heath - lichen and lichen - heath vegetation types are selected by reindeer as preferred feeding areas during winter, in response to such factors as topography, vegetation structure, distribution and availability of forage, ease of locomotion, and wolf harassment. Cladonia mitis, C. rangiferina, and Peltigera aphthosa appear important in the mid-winter diet. Examination of winter feeding sites revealed that utilization levels could be related to the abundance and availability of lichens, and were highest on lichen - heath and shrub - lichen communities.

Under close herding practices almost all of the lichen mat may be seriously disturbed following two years of grazing. The impact of repeated grazing on the same sites may be modified from year to year, by differential snow accumulations.

The recovery of the lichen mat following grazing is very slow and, after severe disturbance to lichen - heath vegetation, a shrub - lichen community may be formed.

The ordination model is recommended as a research tool in displaying the nature and rates of change in community composition under a varying grazing regimen."

Keywords: overgrazing, vegetation - classification, vegetation - ecology, rangeland - rotational use, floristic notes - general

Inglis, J.T. 1975b. The impact of reindeer grazing on selected areas of the winter range in successive years, Mackenzie Delta area, N.W.T., Canada. Proc. First Internat. Reindeer and Caribou Symp., Biol. Papers, Univ. Alaska Spec. Rep. No. 1: 335-341.

The work, which also forms partially the basis for Inglis' M.Sc. thesis (1975), was conducted to assess the impact of reindeer grazing on selected areas of winter range following two years of intensive use. The study area comprised a 1200 sq. km section of the Grazing Preserve located 40 km northeast of Inuvik, N.W.T., an area within the forest tundra transition zone.

"Five 7.3 m x 7.3 m exclosures were constructed on winter range following grazing. All feeding craters within the sites were permanently marked. The exclosures were later examined, disassembled and the crater outlines super-imposed on vegetation maps. The procedure was repeated on these sites the following year. The area of the site cratered was related to vegetation type and was modified in one case by snow conditions. Lichens composed 75 per cent of the vegetation and included Cladonia mitis, C. rangiferina, Cetraria nivalis and Peltigera aphthosa. An average of 41 per cent of the sites was cratered during the two years and of the areas cratered the first year, 26 per cent were reutilized. Maximum values of 51 per cent and 39 per cent respectively were recorded. It is concluded that lichens compose a major part of the mid-winter diet and that, on heavily cratered sites, most of the available forage is utilized in two years of intensive grazing. Differential snow accumulation, in successive years, may reduce the impact of grazing on sheltered sites."

It is suggested that where snow is not limiting, the impact of repeated grazings on lichen rich sites may be severe.

Keywords: vegetation - ecology, overgrazing, rangeland - general

Ito, K. 1978. Plant communities of permafrost in Kinosita, S. (ed.) Joint studies on physical and biological environments in the permafrost, Alaska and northern Canada, July to August, 1977, Inst. of Low Temp. Sci., Hokkaido Univ., Sapporo, Japan. Contrib. No. 1943:105-147.

A synecological treatment of some vegetation types encountered in tundra regions of Barrow, Alaska and Tuktoyaktuk, N.W.T. Included are plant community descriptions for the crest, slopes and base of Ibyuk Pingo, ice-wedge polygons along the Beaufort sea coast, and some small pingos about 3 km south of Tuktoyaktuk. Above-ground biomass was measured at two

locations for Salix alaxensis and Betula glandulosa, along environmental gradients.

Keywords: vegetation - classification, vegetation - ecology, vegetation - productivity, permafrost - pingos.

Janz, A. 1973. Topographic influence on soil and plant nutrients. in Bliss, L.C. (ed.) Botanical studies of disturbed sites in sub-arctic and arctic regions. Environmental-Social Program, Northern Pipelines. Report No. 73-43:27-44.

At three locations - near Tuktoyaktuk, Tunuuk Point and Reindeer Station - field studies were conducted in 1971-72. "Loss on ignition, field moisture, water retention and thickness of the surface organic layer are greatest in depressions and least on hilltops while the active layer depth, surface organic density and pH are greatest on hilltops and least in depressions. Available and total soil nitrogen are no different on hilltops than depressions, but available soil phosphorus and potassium are significantly greater on hilltops than depressions. Standing crop and litter nitrogen and phosphorus are significantly greater on hilltops than depressions. Leaf, stem and litter mass is greatest on hilltops and least in depresssions while cryptogam mass is greatest in depressions and least on hilltops."

Keywords: soils, vegetation - fertility/chemistry, vegetation - productivity

Johansson, J.B. 1964. Canadian Reindeer Project Report: September, 1964. Can. Wildl. Serv., West. Region. Unpubl. Report. 12 pp.

A report on the 1964 operation of the reindeer herd by the then manager and a proposal for future improvements. Range utilization follows a "horseshoe" shaped annual movement between summer ranges on the Tuktoyaktuk Peninsula and inland winter ranges near Crossley Lakes. Suggestions for future research on the herd (range studies, population dynamics, physiological studies, etc.) are made.

Keywords: rangeland - rotational use, rangeland - general

Johnston, A. and S. Smoliak. 1979. The Canadian Arctic. Rangelands 1(5):181-182.

Brief review article on the importance of Canada's northern rangelands to caribou, reindeer and muskox. The authors conclude that although the Canadian arctic is seen as a vast region of about 3.1 million sq. km, it "can support only a limited number of wild or semiwild herbivores. The permanently frozen subsoil and the climate limit the type of vegetation that is grown, thus the grazing factor is of great concern. Excessive use of the summer or winter ranges will drastically reduce their suitability as an herbivore habitat, thus a delicate balance must be maintained."

Keywords: rangeland - general

Kelly, M.A.E. 1932. Reindeer at Mackenzie. Nat. Review 588 (Feb.):215-218.

Brief descriptive article on the potential for establishment of reindeer as a Northern Canadian industry, the success of the Alaskan experiment, the events leading up to the Canadian purchase and the colourful scene when the herders departed western Alaska for the Delta in late 1929 are noted. Written in early 1932, when the herd was "on the point of arriving at the Delta of the Mackenzie River, where it will form the nucleus of vast herds to be planted across Northern Canada, to provide a permanent supply of food and clothing for the Eskimos."

Keywords: historical notes - planning for the herd, historical notes - trek from Alaska

Kerfoot, D.E. 1969. The geomorphology and permafrost conditions of Garry Island, N.W.T. Unpubl. Ph.D. thesis, Dept. of Geography, Univ. of British Columbia. 308 pp.

Although outside of the Reindeer Preserve, Garry Island is similar geomorphically and vegetationally to portions of the Tuktoyaktuk Peninsula, and to Richards Island. The author classifies the vegetation into ten major habitats which are primarily related to drainage conditions and type of geomorphic activity: Dryas hummocks, Cassiope snowpatches, Alnus crispa, Eriophorum tussocks, hummock-tussock transition, stream course willow thickets, sedge-moss flats, mudslump communities, strand communities (gravel bars, marsh-lagoon), polygons (low centred, high centred). Vegetation was mapped in the field at an approximate scale of 1:25,000.

Keywords: permafrost - general, surficial geology, soils, vegetation - classification, floristic notes - general, vegetation - mapping (large-scale), terrain disturbance

Kerfoot, D.E. 1972. Topographic aspects of artificial disturbances to the tundra in the Mackenzie Delta area, N.W.T. in Kerfoot, D.E. (ed.) Mackenzie Delta Area Monograph. Brock Univ., St. Catharines, Ont. 157-174.

The topographic aspects, and their sequential order of development are described for terrain disturbances resulting from the cross-tundra movement of tracked vehicles. Examples illustrated are a 1965 bulldozed seismic line near Toker Point, Tuktoyaktuk Peninsula and a winter road in the vicinity of Sitidgi Creek.

"Four basic relief components may contribute to the topographic aspects of disturbances produced by the cross-tundra movement of vehicles.

These components are related to: (1) the physical removal of material from the tundra surface, (2) a redistribution of this material on or adjacent to the route, (3) thermokarst subsidence, and (4) thermal or mechanical erosion by running water. The first two components are directly associated with the immediate passage of the vehicles and their magnitude can be controlled by the adoption of suitable operational methods in the exploration programme. The other two components are related to a subsequent accentuation of the topographic aspects following the initial disturbance to the tundra surface. Field studies demonstrate that thermokarst subsidence is the most important process involved in this accentuation, and that erosion by water moving along the subsided areas is seldom of more than minor significance."

Kaywords: terrain disturbance, soils, sensitive sites, permafrost - general

Kevan, P.G. 1971. Caribou on the Reindeer Grazing Reserve, N.W.T. in March, 1971. CWS Unpubl. MS 9 pp.

Results are given of aerial counts of caribou on the eastern half of the Reindeer Reserve on March 8 and 9, 1971. The wintering population, in concentrated groups exclusively east of Crossley Lakes, south of 69°N, west of the Anderson River, and north of the Carnwath and Wolverine Rivers, is estimated at 5700.

Keywords: carbou/reindeer conflicts

Kitto, F.H. 1930. The North West Territories 1930. Dept. of Interior, N.W.T. and Yukon Br. King's Printer, Ottawa. 137 pp.

Brief mention (pg. 93) of the plan to introduce reindeer to the region east of Mackenzie Delta, and of the investigation of A.E. Porsild in 1926-1928 to determine suitable grazing areas in northern Canada.

Keywords: historical notes - planning for the herd

Klein, D.R. 1970. Tundra ranges north of the boreal forest. J. Range Manage. 23:8-14.

Tundra ranges are different in many respects from more southern rangelands. Although vast areas in North America are occupied by these rangelands - about 500,000 sq. km and 2,300,000 sq. km in Alaska and northern Canada, respectively - they produce a small biomass of grazing animals per unit area, even though individual herds may be large. Because of long winters, quality and quantity of winter forage, usually lichen for caribou and reindeer, determine population levels that can be supported in an area. Although of high energy level, lichens are slow-growing, fragile, subject to damage from trampling and readily destroyed by fire.

Very short arctic summers produce rapidly-growing and high quality summer forage for grazing animals. Drawing on past experiences in Alaska and the Mackenzie Delta area, the author notes that herding of domestic reindeer and possibly muskoxen may prove successful in some cases, but that the social and economic problems facing development of animal husbandry in the North are of such magnitude that large-scale developments seem unlikely. Wild populations of caribou and muskoxen may offer the best possibilities for large-scale longterm enterprises, as these species are by nature well adapted to the environment and over extended periods of time both the animals and the range vegetation many fare relatively well.

Keywords: rangeland - general, caribou/reindeer conflicts

Klein, D.R. 1980. Conflicts between domestic reindeer and their wild counterparts: a review of Eurasian and North American experience. Arctic 33(4):739-756.

A survey of the literature reveals that the major potential conflicts between reindeer and their wild counterparts are 1) loss of domestic animals to wild herds (although domestic reindeer joining wild herds probably have low breeding success and therefore probably have little genetic influence on the larger wild population), 2) competition for forage, especially winter range, and 3) transmission of diseases and parasites between wild and domestic animals.

Passing mention only is made of the Mackenzie Delta reindeer herd, although the publication has direct relevence to the conflict with indigenous caribou populations in the general area of the Preserve.

Keywords: caribou/reindeer conflicts, disease & parasites, rangeland - general

Krebs, C.J. 1959. Growth studies in the reindeer (Rangifer tarandus) with an analysis of population changes in the Mackenzie Delta herd over the period 1938-1958. Unpubl. M.Sc. thesis, Dept. of Zoology, Univ. of British Columbia. 164 pp.

"A study of the growth of reindeer (Rangifer tarandus) was carried out during the spring and summer of 1958 in the Mackenzie Delta, N.W.T. Growth rates were obtained for four fawns over this period. Their growth is described by Brody's equation and the von Bertalanffy equation. The rate of growth of reindeer fawns is slightly less than that of the Columbian Black-tailed Deer, whereas the birth weight of the reindeer is double that of the Black-tailed Deer.

A description of the relative growth of several body measurements is given. Hind foot length, heart girth, height-at-withers, muzzle circumference, and antler length were measured. The measurement error of height-at-withers and muzzle circumference limits the usefulness of this data."

Growth subsequent to the period of measurement is discussed, and the author believes males reach mature weight (average 128 kg) at four years while females reach mature weight (average 86 kg) at two years.

"The changes in herd numbers and composition of the Mackenzie Delta Reindeer Herd over the period 1938-1958 are analyzed. Of the three population determining factors (natality, mortality, and dispersal), dispersal (losses by straying) was by far most important and natality (number of fawns) was least important in determining the total annual increment to the herd over the period 1938-1958. The age distribution of the herd over the period 1938-1958 has been relatively stable."

A brief history of the reindeer herd is provided. The age distribution's stability suggests herd size is not related to birth rate nor is dispersal related to the number of yearlings present in the herd. Dispersal "appears to be a function more of the human element".

Keywords: herd population dynamics, fawn growth and development, historical notes - general operation

Krebs, C.J. 1961. Population dynamics of the Mackenzie Delta reindeer herd, 1938-1958. Arctic 14:91-100.

This paper presents a summary and analysis of population data on the Mackenzie Delta reindeer herd for 1938 to 1958, a period of 21 years. Changes in total numbers over the recording period are graphed to show general growth and decline patterns. Six native herds, cut out from the main herd between 1939 and 1954, showed similar patterns of change, rising for a few years and then a steady decline resulting in liquidation of the herd when the remaining reindeer were returned to the main herd.

"The effect of each of the three population determining factors (birth rate, death rate, and dispersal rate) on the total annual increment to the herd is analyzed. It is shown that dispersal rate (losses by straying) was the most important factor and birth rate the least important factor in determining variations in the total annual increment to the herd over the period 1938 to 1958. The relative importance of each is indicated in the following ratio: birth rate, 0.2; death rate, 0.6; dispersal rate, 1.0.

The age distribution of the herd over this period is given. There is no evidence of any changing effect of the observed sex and age distributions on either birth rate or dispersal rate within the range of the data available. Dispersal is not related to herd size or to the number of yearlings present in the herd and appears to be primarily a function of factors extrinsic to the herd itself."

Keywords: herd population dynamics, fawn growth and development

Krebs, C.J. and I. McT. Cowan. 1962. Growth studies of reindeer fawns. Can. J. Zool. 40:863-869.

"A study of the growth of reindeer fawns was carried out during the spring and summer of 1958 in the Mackenzie Delta, N.W.T. Growth rates were obtained for four fawns under natural conditions. Early growth of the fawns (0-2 months) can usually be divided into three phases and some possible reasons for this are given. The rate of growth of reindeer fawns is slightly less than that of Columbian Black-tailed deer fawns. Some weight data from different sex and age classes of wild reindeer are given, and it is concluded that the Mackenzie Delta reindeer do not differ greatly in growth pattern from Russian reindeer."

Keywords: fawn growth and development, herd population dynamics

Lambert, J.D.H. 1972. Vegetation patterns in the Mackenzie Delta area, Northwest Territories. in Kerfoot, D.E. (ed.) Mackenzie Delta Area Monograph. Brock Univ., St. Catharines, Ont. 51-68.

General vegetational patterns in the Mackenzie Delta area are described within four major physiographic regions defined by Mackay (1963).

The Mackenzie River Delta (physiographic region II) may be divided into a southern treed portion, a central tree-shrub zone and a tundra area at the mouth of the Delta. The Pleistocene Coastlands (region III) supports a more diverse vegetation including forest, tundra forest, and most prominently tundra, with an additional shoreline type on the Tuktoyaktuk Peninsula. The Uplands Plains (regions IIIg, IV, V, VI) are mostly dominated by open forest, and nine major vegetation types are recognized. The Richardson Mountains (region I) contrast markedly with the Delta and the rolling tundra east of the Delta, and three zones, each with a different combination of topography, soil, vegetation and climate, can be separated: lowland (including coastal plain), foothill and alpine. In addition to those community types briefly described, there are many smaller, identifiable communities present in the varied habitats of the delta region.

"From a vegetation standpoint, the area may be broadly divided into three regions: boreal forest, forest-tundra transition and tundra. Within each region there is a certain degree of homogeneity. Throughout the region as a whole there are a number of species that would appear to have very broad ranges of ecological amplitude. The dominant species appear almost everywhere without regard to land form. For example, such broad ranging species as Betula glandulosa, Vaccinium vitis-idaea, Ledum decumbens and Empetrum nigrum and Arctostaphylos rubra occur on well-drained open slopes, in forested areas in association with Picea glauca and P. mariana, on high-centred polygons, on the raised rims of low-centred polygons and on the sides of hummocks.

Extremes of wet and dry sites have reasonably unique vegetation assemblages. However, intergradations over short distances are common so that a vegetation classification on anything more than a broad scale is difficult. The vegetation is conspicuously a mosaic or re-occurring

assemblages distributed over, and differentiated by, the geomorphic structures of patterned ground."

Keywords: vegetation - classification, physical geography, vegetation - ecology

Lomen, C.J. 1954. Fifty years in Alaska. D. McKay Co. Ltd., New York. 302 pp.

Autobiographical treatment by the former Alaskan "reindeer king" who was a major figure in the establishment of a viable reindeer industry in Alaska. The author describes the role of the Lomen Brothers in their undertaking to supply the Canadian government with 3000 reindeer for the Mackenzie Delta herd including details of the preparation for the drive and highlights of the five year trek (pp. 247-273).

Keywords: historical notes - trek from Alaska

Mackay, J.R. 1963. The Mackenzie Delta area, N.W.T. Geogr. Br., Mines and Tech. Surv., Ottawa. Memoir 8, 202 pp. (republ. 1974, Geol. Surv. Can., Miscell, Rep. No. 23).

A major work on the physical geography of the Mackenzie Delta area, including much data and description on the area covered by the Mackenzie Delta Grazing Preserve. Physiographic regions are delineated, and general notes on historical cartography, climate, vegetation and human geography are included. The accounts are based primarily on field work carried out in the summer field seasons of 1954 to 1958, and 1960. Chapter I includes an introduction, and an account of the early explorations, particularly by Mackenzie (1789), Franklin (1825-1826), Richardson (1926, 1948), Pullen and Hooper (1849-1850), MacFarlane (1957-1966), Petitot (1865-1872), Suinville (1889-1894), Stone (1898) and Harrison (1905-1907). Chapter II deals with Quaternary history, including Pleistocene deposits, glaciation, post-glacial history, and principal geomorphic processes (fluvial action, wind action, weathering, solifluction and soil creep, and permafrost (ground ice, patterned ground and pingos). Growth, development, temperature regimes, distribution, and morphology of pingos of the Pleistocene Mackenzie Delta area and of the modern Mackenzie Delta are considered in detail.

Chapter III, regional physical geography, describes ten physiographic regions which have a certain degree of homogeneity among themselves: Western Uplands (Region I), Mackenzie Delta (II), Pleistocene Coastlands (III), Caribou Hills (IV), Campbell Lake Hills (V), Unfluted Plains (VI), Fluted Plains (VII), Hyndman Lake Hills (VIII), Anderson River Uplands (IX), Mason River Upland (X).

Chapter IV, climate, includes general meteorological information (temperature, precipitation, fog, wind), and break-up and freeze-up information for various locations along the Delta, including dates, the prognosis of break-up, and some controlling factors of break up (dates of initial floodwaters on the Peel and Mackenzie Rivers for Long Rading Post and Reindeer Station, respectively) and freeze-up (air temperatures).

Chapter V describes the regional vegetation. A map is provided, showing the general sequence from north to south: tundra; tundra and scrub willow and ground birch; scrub willow and ground birch; woodland and tundra with much scrub willow and ground birch; open woodland; and continuous woodland. Chapter VI presents data on human geography, using primarily 1961 census data. At the time the entire population was over 2000 of whom about 50 per cent were Eskimo, 30 per cent were white, and 20 per cent Indian, scattered mostly among a few communities (Aklavik, Inuvik, Reindeer Station, Tuktoyaktuk). Other locations were used seasonally by natives (Kidluit Bay, Kittigazuit, Whitefish Station) or were abandoned (Stanton, Point Atkinson).

Keywords: physical geography, vegetation-mapping (regional), surficial geology, bedrock geology, permafrost - ground ice, permafrost - pingos, terrain disturbance, human geography, soils

Mackay, J.R. 1970. Disturbances to the tundra and forest tundra environment of the western Arctic. Can. Geotech. J.:420-432.

"The more important physical disturbances to the tundra environment are discussed with examples. Thermokarst subsidence, not thermal erosion, is shown to be the dominant result of man-induced disturbances, such as those caused by the bulldozing of seismic lines and firebreaks. It is shown that a clear distinction between thermokarst subsidence and thermal erosion is necessary if the causes of the disturbances are to be prevented and minimized, or the results treated. The typical surface disturbance to the tundra results in a deepening of the active layer. Therefore, foreknowledge of the effect of a disturbance on deepening the active layer, together with information on the ice content of the permafrost affected, makes it possible to predict the amount of thermokarst subsidence likely to take place. Three practical examples of three types of ground disturbances are given: a fire near Inuvik, N.W.T., a patch of vegetation trampled and killed by a dog at Garry Island, N.W.T.; and seepage down a walking trail in an ice-wedge area at Garry Island, N.W.T. The effects of the disturbances are illustrated and discussed."

Keywords: terrain disturbance, permafrost - ground ice, wildfire, microclimate, soils

Mackay, J.R. 1979. Pingos of the Tuktoyaktuk Peninsula area, Northwest Territories. Geogr. Phys. Quat. 33(1);3-61.

"Most pingos have grown in residual ponds left behind by rapid lake drainage through erosion of ice-wedge polygon systems. The field studies (1969-78) have involved precise levelling of numerous bench marks, extensive drilling, detailed temperature measurements, installation of water presssure transducers below permafrost and water (ice) quality, soil, and many other analyses. Precise surveys have been carried out on 17 pingos for periods ranging from 3 to 9 years. The field results show that permafrost aggradation in saturated lake bottom sediments creates the high pore water pressures necessary for pingo growth. The subpermafrost water pressures frequently approach that of the total lithostatic pressure of permafrost surrounding a pingo. The water pressure is often great enough

to lift a pingo and intrude a sub-pingo water lens beneath it. The basal diameter of a pingo is established in early youth after which time the pingo tends to grow higher, rather than both higher and wider. The shutoff direction of freezing is from periphery to center. When growing pingos have both through going taliks and also permeable sediments at depth, water may be expelled downwards by pore water expulsion from freezing and consolidation from self loading on saturated sediments. Pingos can rupture from bursting of the sub-pingo water lens. Otherwise, pingo failure is at the top and periphery. Hydraulic fracturing is probably important in some pingo failures. Water loss from sub-pingo water lenses causes subsidence with the subsidence pattern being the mirror image of the growth pattern; i.e. greatest subsidence at the top. Small peripheral bulges may result from subsidence. Old pingos collapse from exposure of the ice core to melting by overburden rupture, by mass wasting, and by permafrost creep of the sides."

Keywords: permafrost - pingos

McMillion, O.M. 1939. Reindeer trek. J. Geogr. 38(4):135-141.

Popular account of the reindeer trek from Alaska to the Mackenzie Grazing Preserve. Difficulties of herding the animals across the arctic coast are briefly described. Because of reindeers' strong homing instinct, especially during the first few months the herd tried frequently to break away and return to the home range. A major snowstorm on July 4, 1931 actually delayed the trek a year when half the herd stampeded west and had to be regrouped. The 100 to 140 km stretch where the Mackenzie River's major tributaries empty their waters into the Arctic Ocean proved to be a major obstacle. Although the herd was pushed to the left bank of the Mackenzie River in winter, 1932, ice conditions and the reindeers' poor winter health would not allow crossing until March, 1935.

"It appears that a steady meat diet and a source of clothing and other necessities is thus assured the Canadian Eskimos of the future. With deer, he will not have to worry about the uncertain supply of whales, caribou, seal, fish, walrus and fur during the long desolate winters."

Keywords: historical notes - trek from Alaska

Miller, M. 1935. The great trek: The story of the five-year drive of a reindeer herd through the icy wastes of Alaska and northwestern Canada. Doubleday, Doran & Co., Inc., Garden City, N.Y. 224 pp.

A popular acount of the reindeer trek from Alaska to the Mackenzie Delta, this book includes a complete description of the journey, anecdotes about day-to-day events, and a number of photographs and illustrations.

Keywords: historical notes - trek from Alaska

Nasogaluak, W. and D. Billingsley. 1981. The reindeer industry in the western Canadian arctic: problems and potential. In Proc. First Internat. Symp. on Renewable Resources and the Economy of the North. M.M.R. Freeman, Ed. Assoc. Can. Univ. North. Stud. and Can. MAB Program. pp. 86-95.

Prepared by the present herd owner, Mr. Nasogaluak, and the industry's business advisor, Dr. Billingsley, the paper discusses the events leading up to private ownership of the herd, recent growth and development of the Mackenzie Delta reindeer industry, potential problems and concerns and possible future developments.

In 1974, following some scientific studies by the Canadian Wildlife Service and a detailed analysis of the available alternatives by Prof. John Stager of Univ. of British Columbia, the herd was sold to the former chief herder, Silas Kangegana. In 1977 he in turn sold the business to Mr. Nasogaluak and Canadian Reindeer (1978) Ltd. was formed.

Subsequent to this, a portable slaughterhouse facility was developed that made possible sale of meat that was surplus to northern requirements to markets in southern Canada. The recent opening of the Dempster Highway permits trailer loads of meat to be taken south to market much more economically than had previously been possible using air freight. An additional cash crop has also developed in the sale of deer antlers to oriental markets as a component in medicines.

At the present time the reindeer herd is growing rapidly and steps are being taken to determine the carrying capacity of the range. Remote sensing studies are presently being conducted under a contract to the University of British Columbia to assess the quality and distribution of rangeland types and to assist in the determination of the carrying capacity of the area. Potential exists for establishing new herds and for starting some small businesses in meat processing, tourism, and dairying, that are dependent on the main reindeer herd.

The settlement of land claims and the major petroleum industry both create an element of uncertainty for the future of the industry.

Keywords: rangeland - general, reindeer products and markets, herd population dynamics

Nowosad, R.F. 1970. Ear tagging reindeer. Can. Wildl. Service, West. Region, Edmonton, Alta. Unpubl. Report CWS-85-70. 9 pp.

Describes the ear tagging program used by the Can. Wildl. Service to allow studies on herd structure, mortality, tertiary sex ratios, behaviour and movement. Colour-coded, numbered ear tags made of aluminum were used to tag reindeer during annual roundups.

Keywords: herd population dynamics, fawn growth and development

Nowosad, R.F. 1972. Annual Report 1971-72, Canadian Reindeer Project. Can. Wildl. Service, West. Region. Unpubl. Report CWS-139-72. 12 pp.

Describes the 1971-72 year of operation and provides information on ear tagging studies, the annual roundup, reindeer productivity, ecological disturbance and future operations. The herd size was estimated at 4300 - 4700 animals, of which 1655-2004 were 1971 fawns. Fawn mortality in 1971 was estimated at 25 to 38 percent. Oil exploration companies conducting seismic studies on the winter range are believed to be creating some land surface disturbances.

Keywords: fawn growth and development, terrain disturbance, herd population dynamics

Nowosad, R.F. 1975. Reindeer survival in the Mackenzie Delta herd, birth to four months. Proc. First Internat. Reindeer and Caribou Symp., Biol. Papers, Univ. Alaska, Spec. Rep. No. 1:199-208.

"Survival of reindeer fawns was studied from 1969 to 1971 on the Mackenzie Reindeer Grazing Preserve, Northwest Territories, Canada. To permit later identification, day old fawns (3,459) were double ear tagged with colored, consecutively numbered Kurl-Lock No.2 tags. Date of birth, weight, sex and tag numbers of each fawn were recorded. Daily collections of dead fawns were undertaken during the first two months following birth. A tally of surviving fawns was gained each August during roundup and corralling. Survival percentages during the first four months following birth varied annually, ranging from 54 per cent to 69 per cent. Up to 10 per cent of fawn deaths occurred on the fawning grounds. Differential survival between sexes was not apparent. Fawn survival appears to be directly related to date of birth, with the highest percentages occurring among those born during the peak fawning period."

Based on sample counts after fawning the numbers of fawns tagged represent an estimated 70-75 per cent of the total fawn crop. Of the 3,459 day-old fawns ear-tagged, 820 were tagged in 1969, 1,209 in 1970, and 1430 in 1971. Survival success varied throughout the fawning period, although in general, fawns born during the peak fawning period exhibited a tendency for greater survival than those born before and after the peak. The results substantiate the theory that reindeer survival was poor during the first four months of life. Five to ten per cent of fawn mortality occurred on the fawning grounds (approximately two months) but 33 to 44 per cent occurrred during the first four months.

Keywords: fawn growth and development, herd population dynamics

Porsild, A.E. 1929. Reindeer grazing in northwest Canada: report of an investigation of pastoral possibilities in the area from the Alaska-Yukon Boundary to Coppermine River. Dept. Interior, NWT and Yukon Br., F.A. Ackland, Kings Printer, Ottawa. 46 pp.

Results of investigations in 1927 and 1928 involving coastal reconnaissance along the Yukon coast, travels up the Mackenzie River to the Great Bear Lake area, and ground surveys in the Eskimo Lake area and the Great Bear Lake to Coronation Gulf area. Regarding Richards Island as grazing land, Porsild notes that the "highest parts of the interior are covered by a hard and fairly dry type of tundra, very different from the low, wet tundra of Western Alaska, and also from the low land north of the Eskimo Lakes. Although not so rich in succulent grasses and herbs as the Alaska tundra, this type of pasture is nevertheless more valuable as summer pasture for reindeer, as it is not so susceptible to damage by the trampling of grazing herds. This pasture with a high percentage of palatable species can therefore be utilized more economically as it is not damaged much by close herding. Bordering the numerous lagoons and sheltered inlets, extensive meadows exist which carry a splendid crop of rather short but highly palatable grasses and sedges".

Surveys were conducted along the arctic coast and within the hinterland between the Delta and Cape Bathurst, and as far south as Great Bear Lake. The potential for reindeer pasture in this area is summarized:

"Summer range: The climate of the Arctic seacoast is considerably affected during summer by the proximity of the ocean. While taken as a whole the climate of this area may be termed dry, having less than seven inches (18 cm) of precipitation, the immediate coast receives some rain and moisture in the shape of fog and snow during the season of growth. During the winter, when the ocean freezes over, the climate of the coast assumes

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the continental character of the hinterland. The cold sea fog has a detrimental effect on tree growth even in its most dwarfed form, and,

therfore, the plant community peculiar to the coastal belt is largely of the sedge-grass type, which further inland gradually changes into heath or moor. The flora of the low tundra near Atkinson point in latitude 70° may well be taken as typical of the coast. We here found about 150 species of flowering plants and of these as many as 54, or more than 33 per cent were grasses or sedges, nearly all highly palatable to reindeer. Of the remaining 96 species only 11 were non-palatable, but not poisonous, while the rest were of varying palatability. Lichens of forage value are deficient everywhere on the coast.

Winter range: Travelling away from the coast the general aspect of the vegetation gradually changes on the second and third days' march. Various species of the beautiful white-headed cottongrass (Eriophorum) so common on the coast now predominate only in swampy places. Travelling on foot becomes exceedingly tiresome because the ground is covered with low scrub or heath which grows in a thick soft carpet of mosses and lichens into which one sinks ankle-deep at every step. Willows and other dwarf trees of the tundra dominate the herbaceous vegetation. In sheltered places they no longer hug the ground but grow upright forming little thickets.

This forage type occupies all the higher ground on both shores of the Eskimo lakes and as winter grazing land ranks with the best. The young shoots of willow and ground birch are much sought after by the reindeer in the fall and early winter, and it is in this kind of winter pasture that the reindeer put on their "back fat". The maximum development of the fruticose species of lichens commonly known as reindeer moss is attained in the open timber some distance south of the edge of the woods. Not only is the ground there in places covered with Cladonias and Cetrarias almost to the entire exclusion of herbaceous species of plant life, but from the dead lower branches of the stunted trees, black and gray Alectoria hang in great profusion. The latter form of winter range occupies large areas south of the Eskimo lakes but it attains its greatest perfection in Great Bear Lake district."

Estimates for carrying capacity of these ranges are suggested, and allowing 16 ha per head (40 acres per head) the area from the Alaska-Yukon boundary to the west side of Franklin Bay could support 250,000 head. The coastal tundra is somewhat different from Alaska tundra. "It is not quite so rich in succulent grasses and sedges but this deficiency is generously compensated for by the texture of the turf which is rather hard and firm and not so sucesptible to damage from trampling of herds. The hinterland, near the edge of the forest, on which the reindeer depend for winter pasture is exceptionally rich in numerous species of lichens commonly known as reindeer moss. Suitable winter grazing is found everywhere at some distance from the coast. The mainland between point Separation and Anderson river is partly timbered and all good winter range."

Keywords: historical notes - planning for herd, vegetation - classification, rangeland - rotational use, rangeland - general, rangeland - carrying capacity, physical geography

Porsild, A.E. 1936. The reindeer industry and the Canadian Eskimo. Geogr. J. 88:1-19.

Establishment of the Mackenzie Delta herd is outlined in some detail. A reason for initiating the experiment was the apparently dwindling caribou population. The author notes that while lack of sufficient data on the status of caribou makes it difficult to draw conclusions, the caribou had entirely disappeared from certain areas of the Northwest Territories in the decades prior to the 1930's. Reasons for this include increasing use of the rifle for hunting by Eskimo and a growing presence by man - native and non-native - in the north.

The results of a study of suitable grazing pasture conducted in northern Canada by Porsild and his brother in 1927 and 1928 are discussed. Their surveys indicated a number of suitable areas for herd establishment, with the large tract of territory just east of the Mackenzie Delta the most favourable initially.

Included in the paper are accounts of topography, interesting permafrost features, botanical notes, and remarks on general climate comparing areas in Keewatin and Mackenzie Districts, N.W.T.

Concluding, Porsild notes that "grazing surveys conducted by the writer during the eight summers and five winters he has spent in the Mackenzie and Keewatin Districts have shown that large areas from the northern edge of the transcontinental forest north towards the Arctic Ocean are suitable for the grazing of reindeer."

Keywords: historical notes - establishment of herd, rangeland - general

Porsild, A.E. 1938. Earth mounds in unglaciated arctic northwestern America. Geogr. Rev. 28(1):46-58.

A review paper that considers the unique "pingo" type of permafrost "mound" distinguishing it from other types of raised permafrost mounds formed under hydraulic pressures. Examples from the Tuktoyaktuk area are generally described and the growth and development of pingos, involving the progessive downward freezing of a body of water under a former lake, is speculated. The dynamic nature of pingos is discussed, and pollen analyses and the study of the peat sedimentation on pingos and adjacent to them, indicate the summits were once the floors of lakes.

Keywords: permafrost - pingos, physical geography

Porsild, A.E. 1942. Reindeer and caribou grazing in Canada. Trans. N. Amer. Wildl. Conf. 7:381-391.

This article discusses general biology, food habits and range requirements of reindeer and caribou, noting the similarities.

Food habits of reindeer and caribou are alike. However, while caribou roam freely, reindeer are typically herded closely to prevent straying and to protect them from wolves, and this requires a pasture of good enough quality to permit the herd to remain for several days, or even weeks, within a fairly limited area.

Summer range requirements: 1) areas where even part time relief can be obtained from mosquitoes, gnats, warble and nostril flies, 2) areas where ground is not too stony and dry, a condition which can cause foot injuries, 3) there should be a good supply of green herbage suitable for deer, and 4) like other herbivourous animals, reindeer are salt-starved after spending winter inland, so it is desirable that the summer range, where possible, be located near the sea.

Winter range requirements: 1) areas of lichen and low browse for winter foraging, 2) the snow-cover must permit the deer to paw through to the ground. Snow conditions are usually best in or near the edge of woodland, in open muskeg or in sheltered mountain valleys.

Fawning grounds: the distance between winter and summer ranges for practical reasons should not be too great, and a suitable location needs to be selected where the herd may stop during the fawning season. The location should be sheltered and well-supplied with lichens.

Given sufficient space on a range, both caribou and reindeer are light grazers. Herded reindeer within a limited area require care be taken to prevent overgrazing. Summer range is most liable to damage by trampling when wet and soft, with lichens on the summer range suffering most. On the winter range, lichen when overgrazed requires 20 years or more to recover. Based on studies in Europe and Alaska, a controlled system of rotation is required to avoid overuse.

Reindeer effects on wildlife include the disappearance of caribou from ranges occupied by reindeer, the destruction of bird nests on low coastal flats, and the attraction of foxes, wolves and ravens to the herd. The author feels that "reindeer grazing is not a serious menace to wildlife and in future is not likely to cause serious interference."

Keywords: rangeland - general, wildlife, caribou/reindeer conflicts, rangeland - rotational use

Porsild, A.E. 1943. Materials for a flora of the continental Northwest Territories of Canada. Sargentia 4:1-79.

Preliminary catologue of the vascular flora of the continental N.W.T. based on the author's and others' collections. A brief history of botanical work in the region is presented and of the 761 plants constituting the then known flora of the Mackenzie (including the Yukon coast) and Keewatin Districts, 345 are enumerated in this catologue (including 14 believed to be "new" to the flora of Canada) with locational and habitat data, and collection notes.

Included are numerous collections from within and near the Reindeer Preserve.

Keywords: floristic notes - vascular plants, vegetation - ecology, phytogeography

Porsild, A.E. 1947. The Mackenzie Delta Reindeer Grazing Reserve, 1947. N.W.T. and Yukon Services, Lands and Development Services Br., Dept. Mines and Resources, Ottawa. Unpubl. mimeo. report. 8 pp.

General description of the reindeer industry and the range resources of the Grazing Reserve. An overview of the area with general notes on topography, climate, location of treeline, and human settlements is provided. The major vegetational types are listed; white spruce forest, muskeg forest, willow and alder thickets, lowland meadows, subalpine meadows (on east slope of the Richardson Mtns.), upland tundra, lowland tundra and marsh. Lakes and river channels probably occupy more than two-thirds of the Mackenzie Delta and more than half of the surface on the low, marshy plain which separates the Eskimo Lakes from the seas.

The Reserve in 1942 comprised roughly 17,100 sq. km (6600 sq. mi) and extended from the Delta east to the Anderson River, and from the coast, including Richards Island, inland to approximately the northern limit of continuous forest. Porsild identified three pasture types: "(1) the low, lake-filled, rather wet arctic tundra which is characterized by low grasses and sedges, particularly the arctic cotton (Eriophorum vaginatum) and by other herbaceous plants together with some dwarf shrubs, but lacking proper trees; (2) upland tundra of rolling low hills intersected by poorly defined drainage systems of creeks and small rivers. The vegetation of the upland tundra may be designated as a sedge-browse type in which dwarf shrubs, mosses, and lichens (reindeer moss) dominate. Along the creeks and in sheltered places, alder and willow form dense thickets. This type is classed as spring, summer, and autumn pasture. Were it not for the deficiency of firewood, this type of country would also be suitable for winter pasture; (3) the transition from upland tundra to open muskeg-spruce is a very gradual one. The latter is characterized by open, stunted spruce forest with a ground cover of dwarf shrubs growing in a dense carpet of "reindeer moss" chiefly Cladonia and Cetraria. The latter is often so abundant that it imparts a greenish-white tinge to the country when viewed from the air. This type of country provides the best winter range for reindeer."

Careful observation of the tundra vegetation in the vicinity of Reindeer Station was made, the author stating that "the lichen cover, which originally had formed approximately 10 per cent of the total vegetation, had been materially reduced and . . . grasses, sedges and forbs had increased as a result of grazing." While the author feels the range within 40 km (25 mi) of the Reindeer Station could possibly support a herd of 5000 head indefinitely, he suggests more widespread winter grazing practices. Minor changes in vegetation cover, particularly in the abundance of lichen, are noted on the fall-spring, and summer rangelands on Richards Island.

The author concludes "(1) that the reindeer in the reserve are healthy and thriving (2) that the experience gained in the course of the first 12 years of the experiment proves that the area selected is eminently suited to reindeer (3) that young Canadian Eskimos can be trained to become efficient reindeer herders and (4) that the industry, still in the experimental stage, is capable of considerable expansion provided means are adopted to make reindeer ranching more attractive to natives and reindeer herding more effective."

Keywords: rangeland - general, rangeland - carrying capacity, rangeland - rotational use, vegetation ecology, historical notes - general operation, overgrazing, herd population dynamics

Porsild, A.E. 1954. Land use in the arctic. Can. Geogr. J. 48:232-243; 49:20-31.

Arctic land surfaces are among the least productive in the world, and arctic vegetation is affected by the severe climate under which plants grow. This article documents direct use of arctic plants by man, gardening and agricultural possibilities in the arctic, and animal husbandry, however it is primarily devoted to the discussion of reindeer herding, including its history and development, reindeer grazing, winter and summer range requirements, and the possibilities for widespread herding in North America. Particular mention is made of lichen, a major component of the winter diet, including growth rates, major forage species, and lichen biology reproduction, and nutritive value. Estimates of carrying capacity calculated for Alaskan reindeer herds are between 7 and 24 ha per reindeer depending on the quality of the winter forage. The author estimates that probably more than 1,000,000 reindeer could be supported in northern Canada in those areas where there are no caribou, given these figures for carrying capacity.

Keywords: historical notes - general operation, rangeland - carrying capacity, rangeland - general

Porsild, A.E. 1957. (1964, revised) Illustrated flora of the Canadian arctic archipelago. Nat. Mus. Can., Mus. Nat. Sci. Bull. No. 146. 218 pp.

A guide to the 340 species and major geographical races of vascular plants in the Canadian arctic archipelago, including distribution maps, habitat and collection notes, identification keys, and taxonomic notes.

Keywords: floristic notes - vascular plants, phytogeography

Porsild, A.E. and W.J. Cody. 1980. Vascular plants of the continental Northwest Territories, Canada. Nat. Mus. Can., Mus. Nat. Sci., Ottawa. 667 pp.

A comprehensive treatment of 1112 species found in the continental N.W.T., including distribution maps and line drawings of plants, a

description of the area and its six phytogeographic zones, a tabulation of families, genera, and species, a history of botanical collecting, taxonomic notes and detailed identification keys. The Reindeer Preserve falls almost entirely within one phytogeographical province, an area that includes the Mackenzie River delta and the coastal plain between the lower Mackenzie and Anderson rivers. Of that province, the authors write "Owing to the ameliorating influence of the waters of the great north flowing Mackenzie, the flora of its delta is surprisingly rich in southern species, and may be considered a northern extension of that of the upper Mackenzie Basin; near the Arctic Coast southern species mingle with truly arctic or maritime species. A few Amphi-Beringian species are found on the higher and non-alluvial islands north and east of the delta proper, and on the Caribou Hills which flank the East Branch of the Mackenzie Delta."

Keywords: floristic notes - vascular plants, phytogeography, vegetation - ecology

Porsild, R.T. 1971. A seal for the government. Alaska J. 1(2): 19-21.

Description of an incident that occurred during the trek from Alaska, in the winter of 1932, as the reindeer and herders were approaching the Alaska-Yukon border. Low on food for the dog teams, they 'purchased' a hair seal from Eskimos trapping along the coast at a cost of two reindeer.

Keywords: historical notes - trek from Alaska.

Radforth, J.R. 1973. Immediate effects of wheeled vehicle traffic on tundra during the summer. Environmental-Social Program, Northern Pipelines. Report No. 72-73-12. 32 pp.

Field tests at Tunuuk, Richards Island, NWT to study immediate effects on the tundra surface by wheeled vehicles. Four vehicles operated on four test sites were compared to tracked vehicle tests conducted earlier at the same sites. A "tundra disturbance classification system" was applied and vehicles with large, soft tires created less disturbance than tracked vehicles of the same weight.

Keywords: terrain disturbance

Rampton, V.N. 1972. Surficial deposits of portions of the Mackenzie Delta (107C), Stanton (107D), Cape Dalhousie (107E), and Malloch Hill (97F) map-sheets. in Kerfoot, D.E. (ed.) Mackenzie Delta Area Monograph. Brock Univ. St. Catharines, Ont. 15-27.

Surficial deposits are mapped at a general level for the Tuktoyaktuk Peninsula and adjacent areas and ten major units are defined. Most of the Peninsula is covered by glaciofluvial deposits, till and till-derived deposits, or lacustrine depsoits of thermokarst origin. Lakes, mainly of thermokarst origin, and abandoned lake basins which are often marshy and contain peat accumulations are common throughout the area.

Keywords: surficial geology, physical geography

Rampton, V.N. and J.R. Mackay. 1971. Massive ice and icy sediments throughout the Tuktoyaktuk Peninsula, Richards Island, and nearby areas, District of Mackenzie. Geol. Surv. Can. Paper 71-21. 16 pp.

Massive bodies of subsurface ice and icy sediments on the Tuktoyaktuk Peninsula, Richards Island and adjacent areas are common, with massive ice most common at a depth of 12 m, and icy sediments, where present, occurring with relatively constant frequency to a depth of at least 43 m. Examples of both features are described from man-made excavations and coastal exposures at Tuktoyaktuk, and problems presented for construction and development are briefly considered.

Keywords: surficial geology, permafrost - ground ice, terrain disturbance

Rampton, V.N. and M. Bouchard. 1975. Surficial geology of Tuktoyaktuk, District of Mackenzie. Geol. Surv. Can. Paper 74-53. 17 pp. + 2 mapsheets.

Surficial geology around the Tuktoyaktuk townsite is described and mapped at 1:25,000 scale. Mean annual ground temperature is -8°C, permafrost reaches a depth of 370 m on undisturbed sites, and the active layer is from 7.6 cm to more than 100 cm. Coastal retreat, rapid where massive ground ice or ice-rich sediments are near sea level and vulnerable to exposure by wave erosion, is mapped from 1950 and 1971 aerial photography. The authors note that care is needed to avoid surface disturbance that leads to thermokarst.

Keywords: surficial geology, permafrost - ground ice, terrain disturbance

Rea, K.J. 1968. The political economy of the Canadian north: An interpretation of the course of development in the northern territories of Canada to the early 1960s. Univ. Toronto Press, Toronto. 453 pp.

A brief historical account is included of the Mackenzie Delta reindeer industry, in particular the unsuccessful attempts to establish a number of nativeowned herds during the 1940's and 1950's. The reindeer project is somewhat unique in that it is the only long-term government programme in the Canadian north designed to generate indirect benefit by providing natives with income-earning opportunities. Shorter-lived, sometimes unsuccessful examples exist in home and handicraft industries, instruction in economical management of fur, fish and other wildlife resources, and even the operation of retail stores.

Keywords: historical notes - general operation

Revel, R.D. 1978. The International Biological Programme in the subarctic and arctic regions of Canada. In Northern Transitions, 2nd Nat. Worksh. of People, Resources and the Environment N. of 60°. Can. Arct. Res. Comm.:237-250.

A summary of CCIBP-CT proposed Ecological Sites in tundra areas north of the treeline (Panel 9) and in subarctic Yukon and N.W.T. (Panel 10). A number of identified sites are located within the Reindeer Preserve, including: Panel 9 (Region 4, North Slope and Mackenzie District) - Toker Point, Caribou Hills; Panel 10 - Caribou Hills, Anderson River Delta, Kagluk River and Estuary, Dolomite - Campbell Lakes. Site features are briefly tabulated.

Keywords: sensitive sites

Ritchie, J.C. 1974. Modern pollen assemblages near the arctic tree line, Mackenzie Delta region, Northwest Territories. Can. J. Bot. 52:381-396.

The results of palynological investigations on surficial lake sediment and moss polsters are presented for 39 sites in the forest tundra transitional area immediately east of the Mackenzie Delta. As well, vegetation cover values are provided for the major plant species in six community types, (i) Picea glauca - Rhododendron - Dryas, 2) Picea glauca-Betula resinifera, 3) Picea mariana - Larix, 4) forest-tundra (transect), 5) cottongrass-lichen (transect), 6) Dryas tundra. General vegetation is considered under the following headings: I Boreal Forest: (a) Closed Crown Spruce Forest, (b) Open Crown Spruce Forest, II Forest-Tundra, III Tundra: (a) Eriophorum-Carex Tundra, (b) Upland Tundra on Fine-Textured Soils, (c) Upland Tundra on Coarse-Textured Soils.

Keywords: vegetation - classification, floristic notes - general, vegetation - palynology

Ritchie, J.C. 1976. The Campbell Dolomite Upland near Inuvik, NWT - a unique scientific resource. Musk-Ox 18:70-75.

"The Campbell Dolomite Upland, comprising less than 0.01 per cent of the Mackenzie kiver basin, is unique in its scientific attributes. It has its own distinctive tectonic style; it is the only outcrop area of the Aklavik Arch in the Mackenzie River basin. The Precambrian, early Palaeozoic, and late Mesozoic sedimentary rocks have produced structural and chemical characteristics of primary significance in determining unique and rare biological phenomena. Arctic-alpine plants (some endemic to Megaberingia, others to northwest North America) occur in unstable habitats. Rich assemblages of arctic-alpine calciphiles occur, and the vegetation, undisturbed by fire for several centuries, provides several excellent examples of rare communities. At least one notable member of the fauna is rare and is on the "endangered species" list. An unusual meromictic lake has provided an unprecendented stratigraphic record of the vegetational and environmental history of the area. The area is unrivalled as a natural laboratory that is accessible for teaching and research in several branches of the natural sciences. However, current and apparently uncontrolled activities are accelerating the disruption of the area; if unchecked they will quickly render it useless for science."

Keywords: sensitive sites, floristic notes - general, terrain disturbance

Ritchie, J.C. and F.K. Hare. 1971. Late-Quaternary vegetation and climate near the arctic tree line of northwestern North America. Quat. Res. 1:331-3442.

"Earlier studies in Alaska and northwest Canada have shown inconsistent evidence for the expected northward extension of the Arctic tree line during the Hypsithermal Interval. Only megafossil evidence has supported this suggestion; the palynological findings have been inconclusive. The Tuktoyaktuk Peninsula, in the Northwest Territories of Canada, offers critical sites for studies of late-Pleistocene ecology, because of its geological, biotic, and climatological features. Palynological and megafossil evidence is presented from sites on the Tuktoyaktuk Peninsula, indicating northward advance of the Arctic tree line during the period 8500-550 B.P. Relative pollen frequencies of a core of lake sediment suggest a late-Pleistocene sequence as follows; 12,900-11,600 dwarf birch tundra; 11,600-8500 forest tundra; 8500-5500 closed-crown spruce-birch forest; 5500-4000 tall shrub tundra; 4000-present dwarf birch heath tundra. These results suggest that during the Hypsithermal Interval the Arctic Front (July position) was further north, over the Beaufort Sea, a displacement from its present position of about 350 km. The Tuktoyaktuk Peninsula, presently occupied by tundra, and dominated by the Arctic airstream in July, was apparently under forest, with warm, moist Pacific air during the Hypsithermal Interval.

Keywords: vegetation - palynology, macroclimate

Rutherford, J.G., J.S. McLean and J.B. Harkin. 1922. Report of the royal commission to investigate the possibilities of the reindeer and musk-ox industries in the arctic and sub-arctic regions of Canada. King's Printer, Ottawa. 99 pp.

Appointed to enquire into the possibilities of establishment of reindeer and musk-ox herds in the Canadian north, the commission carried out four public hearings in 1920 and received additional written submissions and documents. This report summarizes general aspects of muskox and reindeer biology and management, briefly considers potential problem of conflict with native caribou herds and the likelihood of native people developing into successful herders, and makes recommendations on the establishment, on an experimental basis, of reindeer herds in northern Canada.

"There is no reasonable doubt as to the possibility of reindeer being able to live and thrive in most parts of northern Canada." ". . . however, it must not be forgotten that if the reindeer is to retain his quality of domestication, which is, after all, the only argument in his favour as against the caribou, he must of necessity be kept under a measure of restraint." Reindeer herding in northern Canada, according to the report, could have a number of benefits: 1) to provide reliable and economical food and clothing supplies for the natives, both Esquimaux and Indians, 2) to provide future food supplies for white men who may go in to develop or

exploit mineral and other natural resources of the north, and 3) to lay the foundation for a possible future commercial meat industry.

The report clearly notes that great care needed to be exercised in selecting locations for establishment of herds. Requirements regarding topography (for relief from flies, natural shelf and ease of travel) and vegetation (for adequate summer and winter diets) are listed, although "unquestionably the most important point to be considered in the locations for reindeer herds, especially on the mainland" is the danger of conflict with wild caribou.

Recommendations made by the commission regarding reindeer were:

"That small experimental reindeer herds be established in a number of such localities as may, after searching Departmental investigation, be found most desirable in points of vegetation and otherwise.

That in the selection of the localities for these stations, the needs of the natives, in the matter of food supply, be given the most careful consideration.

That where suitable arrangements can be made, the various missionary bodies be requested to co-operate in an earnest effort to ensure the success of the undertaking, not only by influencing the natives to protect the animals, but also by encouraging them to learn how to handle and care for them so that, as in Alaska, they may become herders and eventually owners of herds.

This will involve the gradual working out of a system similar to that so successfully followed by the United States Government in Alaska, whereby small numbers of reindeer are given to the natives in recognition of the interest and industry which they show in the work.

That at least one experienced Lapp deer-man should be detailed to each herd, this being necessary, not only to avoid mistakes in handling the deer, but to ensure that the instruction given to the natives is of a sound and practical character.

That in view of the information furnished by Dr. Grenfell and Mr. W.J. Kjellman, as set forth in Appendix No. XI, and referred to elsewhere in this report, to the effect that a number of Lapp deer-men might be induced to come to Canada and bring their herds with them, steps be taken at once to ascertain the exact conditions in that regard.

That if these conditions are found to be as represented, negotiations be entered into immediately with the view of securing as many of these desirable people as possible, in order that their services may be utilized in the development of the reindeer industry in such areas as may be approved for that purpose."

Keywords: historical notes - planning for herd, rangeland - general

Sayn-Wittgenstein, L. 1973. The Mackenzie River Delta as seen by ERTS. Paper presented at the I.U.F.R.O. Remote Sensing Symp., Frieburg, Sept. 17-21, 1973. Unpubl. Rep. 13 pp.

Five LANDSAT scenes of the Mackenzie Delta area were examined on a colour additive viewer, an electronic density slicer and using conventional interpretation techniques on photo-prints. Major features of the Delta were delineated, including old and new Delta, forested land, tundra, silt and mud-bars, the boundaries of recent, large wildfires, and several categories of water turbidity in lakes, the river channels and the open Beaufort Sea.

Some potential uses for LANDSAT imagery in the north, and in particular, in the Mackenzie Delta area are suggested, including the study of surficial geology, permafrost, vegetation and drainage patterns. Temporal coverage by satellite could allow studies on spring break-up, the thermal cycle of water bodies, erosion along slopes, channel shifting in the Delta, seasonal changes in water turbidity in the Delta, and the detection of large wildfires.

Keywords: remote sensing, physical geography, vegetation - mapping (regional)

Scotter, G.W. 1966. The reindeer journey. North 13(6):4-8.

Popular account of the reindeer drive across Alaska to the Mackenzie Delta, 1929-1935, "an epic in the annals of northern travel". (see Scotter 1978).

Keywords: historical notes - trek from Alaska

Scotter, G.W. 1967. Den fantastiska flyttningen. Samefolket 48(6-7):-133-135.

Popular account written in Swedish of the reindeer drive from western Alaska to the Mackenzie Delta area by Andrew Bahr and his crew during 1929-1935 (see Scotter 1978).

Keywords: historical notes - trek from Alaska

Scotter, G.W. 1968. Study of the range resources and management of the Canadian reindeer operation. Can. Wildl. Serv., Edmonton, Alta. Project No. M 3-1-12. Unpubl. Rep. 65 pp.

Two approaches were taken in the study: (1) Past management of Reindeer Station was determined by studying files and reports and by interviewing persons associated with the operation at varying times, and present management was evaluated based on animal husbandry and range

management principles and the author's experience; 2) An ecological reconnaissance of the Reindeer Preserve was carried out in summer, 1965 and 1966, at 182 locations. Range condition classes (excellent, good, fair, poor) and range trend (improving, deteriorating, no marked change) were noted, and at sites near Inuvik, periodic collections over ten months were made of a number of important forage plants to determine chemical composition.

1) Management of the Reindeer Industry. A summary of past experiences of herd management is given. The author feels the operation suffered from continuous attempts to apply Scandinavian practices. Close herding forced reindeer to overgraze parts of the range, utilize plants that would normally be avoided, and likely was the problem of weak bones and broken backs that occurred not infrequently before 1962. Selective breeding, a higher percentage of female animals, and the culling of older reindeer would improve the quality of the herd.

A study of the market potential for reindeer meat is required to determine at what size the reindeer herd should be established. "Since caribou appear to be making greater use of the Reindeer Preserve in recent years and caribou are available in the Richardson Mountains to the west of the Mackenzie Delta, there would appear to be less need of the reindeer industry than previously existed. In addition, fewer native people are dependent on hunting for food and the number is likely to decrease in the future. Careful consideration should be given to the benefits of caribou versus the benefits of reindeer on the Preserve."

2) Ecological Reconnainssance of the Range. Condition and trend studies suggest the carrying capacities of summer, winter and spring-fall ranges have been adequate for the size of the reindeer herds. Although certain portions of the range have been overgrazed, under proper grazing management, the operation should support from 25,000 to 30,000 reindeer. There is a need for fire prevention and control on the winter range since a major fire could destroy the basis for the whole operation.

"The results from chemical analyses of forage plants indicate that protein is likely deficient on the winter range. Additional effort to determine nutritional deficiencies should be undertaken, if the reindeer operation is to continue."

Appendix A lists plant species (vascular plants, mosses and lichens) collected on the Reindeer Preserve during 1965 and 1966.

Keywords: historical notes - general operation, herd population dynamics, floristic notes - general, overgrazing, vegetation - classification, vegetation - fertility/chemistry, vegetation - productivity, rangeland - carrying capacity, rangeland - general, caribou/reindeer conflicts.

Scotter, G.W. 1970a. Reindeer husbandry as a land use in northern Canada. Proc. Conf. on Productivity and Conservation in Northern

Circumpolar Lands. Edmonton, Alta. 15-17 Oct., 1969. IBP, IUCNNR. IUCN Publ. Ser. No. 16:159-169.

Early attempts to establish Canadian reindeer industries were made at 1) St. Anthony, Newfoundland (1908), 2) Anticostic Island, Quebec (1918), 3) Great Slave Lake, N.W.T. (1911), 4) Southern Baffin Island, N.W.T. (1921) and 5) Mackenzie River Delta, N.W.T. (1935). Only the Delta experiment continued, the others lapsing after a few years from lack of supervision and inadequate herding or lack of suitable forage. Location, vegetation, climate and projected carrying capacity of the Mackenzie Delta Reindeer Grazing Preserve are summarized, and past problems in the herd's management are reviewed. It is noted that the original objective, to establish a main herd with smaller native-owned herds set up as growth permitted, was never achieved although the reasons for failure are many and complex.

Growth and decline of the herd from 1935 to 1969 is graphed. In this period, 65,000 reindeer fawns were born, while 29,000 reindeer were slaughtered and about an equal number lost due to natural losses, including straying. Losses have been as much as 36 per cent of the herd in one year, and in 1969 the total herd consisted of 2,800 based on an aerial count.

The author concedes that there is little doubt that availability of fresh reindeer meat at modest cost has contributed to the Delta's economy, and that reindeer raising is biologically feasible in the area. However, concern is noted about an exotic species (reindeer) replacing an indigenous one (caribou) that might well be a more efficient user of native forage, and a game-ranching type of caribou operation might be more acceptable. Native animals in other areas of northern Canada - caribou, moose, muskoxen - "might offer the best potential for conversion of vegetation into useable meat products. Under free-ranging condition, they select the highest quality forage available to them in order to meet their nutritive requirements. By comparison, reindeer are at a marked disadvantage because they must be confined to be of greatest value to their owners."

Keywords: historical notes - planning for herd, rangeland - carrying capacity, caribou/reindeer conflicts, overgrazing, rangeland - general

Scotter, G.W. 1970b. Poronhoito maankayttomuotona Pohjois-Kanadass. Poromies 37(6):3-12.

Translation of Scotter (1972) "Reindeer ranching in Canada" into Finnish.

Keywords: rangeland - general, rangeland - carrying capacity, caribou/-reindeer conflicts, overgrazing

Scotter, G.W. 1972a. Reindeer ranching in Canada. J. Range Manage. 25(3):167-174.

Due to the initial success of Alaska's experiment to import reindeer from Siberia in the 1890's, five attempts were made to establish commercial herds in Canada early in this century. The most ambitious attempt, the Mackenzie Delta herd, was intended to supplement the region's wildlife resources and to improve the Eskimo's economic condition by creating a number of viable native-owned herds. Location vegetation and climate of the Mackenzie Delta Reindeer Grazing Preserve is briefly described. It is estimated that approximately 30,000 reindeer could be supported provided all of the range were utilized and good management practices were employed. The author notes a number of past problems with the enterprise: predators, poaching and disease, improper application of "Lappish herding techniques", and lack of effective direction, partly because some of its managers have not had experience with livestock or wildlife management, partly because a coherent, practical policy was not set, partly because of a lack of biological data." The social and economic future of the herd and the possibility of game-ranching caribou are briefly discussed.

Keywords: rangeland - general, rangeland - carrying capacity, caribou/reindeer conflicts, overgrazing

Scotter, G.W. 1972b. Chemical composition of forage plants from the Reindeer Preserve, Northwest Territories. Arctic 25(1):21-27.

"Quantitative analyses of crude protein, crude fat, crude fiber, ash, calcium, phosphorus, and carotene were performed on 9 forage species, collected on five dates during a year [1965-66]. Crude protein levels were low in most forage species by mid-winter. Phosphorus levels were low in most plants throughout the year. Lichens, an important winter forage of reindeer, appear to be deficient in crude protein, calcium, phosphorus, and carotene," while being good sources of carbohydrates. The vascular forages (Salix glauca, Betula glandulosa, Ledum palustre var. latifolia, Eriophorum vaginatum) appear to be relatively high quality during their most nutritious period, the early growth stages of summer. "The results of the chemical analyses demonstrate the importance of variety in forage types, including shrubs, grass and grass-like plants, and lichens".

Keywords: vegetation - fertility/chemistry

Scotter, G.W. 1972c. Reindeer journey on the rim of the arctic. The Alaska Journal. 2(2):57-60.

Popular account, including photographs, of the reindeer drive from western Alaska to the Mackenzie Delta area by Andrew Bahr and his crew during 1929-1935 (see Scotter 1978).

Keywords: historical notes - trek from Alaska

Scotter, G.W. 1978. How Andy Bahr led the great reindeer herd from western Alaska to the Mackenzie Delta. Can. Geogr. J. 97(2):12-19.

Popular account of the five year, 2600 km trek from Alaska to the Mackenzie Delta during 1929 to 1935. On December 26, 1929, 12 men led by Andrew Bahr, an experienced Lapp herder, left the settlement of Napaktolik, Alaska and drove 3450 reindeer towards the arctic coast. Many hardships were encountered, the reindeers' health deteriorated, the weather was particularily poor, and even when the west bank of the Mackenzie River was reached it was over two years before ice conditions allowed the reindeer and herders to cross to the Reindeer Grazing Preserve. Of the 2,382 reindeer that were counted through the corrals at Kittigazuit in March, 1935, only 20 per cent, were earmarked, indicating all the others had been born on the trail. Though the total herd was 618 short of the 3000, the Lomen Reindeer Company in Alaska had promised, the birth of approximately 800 fawns within a few weeks restored the deficit.

Keywords: historical notes - trek from Alaska

Scotter, G.W. and J.E. Miltimore. 1973. Mineral content of forage plants from the Reindeer Preserve, Northwest Territories. Can. J. Plant Sci. 53:263-268.

Quantitative analyses for copper, molybdenum, iron, manganese, zinc, magnesium and potassium are presented for samples of eight forage species on the Reindeer Preserve: Salix glauca, Betula glandulosa, Ledum palustre var. decumbens, Arctagrostis latifolia, Eriophorum vaginatum, Cladonia mitis, C. rangiferina and Cetraria nivalis.

Mineral levels were generally low in the three lichen species with average copper levels of five times less than the lowest value recommended for domestic sheep and average zinc levels two to four times less than the recommended value for domestic ruminants. Based on the results, the authors suggest the testing of copper and zinc injections to determine if weight and fecundity could be significantly increased.

Keywords: vegetation - fertility/chemistry

Scotter, G.W. and E.S. Telfer. 1976. Potential for red meat production from wildlife in boreal and arctic regions. in Proc. Circumpolar Conf. on Northern Ecology, Nat. Res. Council and Can. Nat. Comm., Scientif. Comm. on Problems of Environment. pp. I23-I44.

Game ranching of native and/or introduced wild ungulates for meat production in northern regions is a practical solution to the problem of insufficient protein supplies for northern inhabitants. Game ranching might provide acceptable employment for northern people, and it would be in harmony with proper land management by causing minimum environmental disturbance. Ungulates considered include caribou/reindeer although the Mackenzie Delta herd is only briefly mentioned.

Keywords: rangeland - general, reindeer products and markets, caribou/-reindeer conflicts.

Sims, R.A. and P.A. Murtha. 1981. A multistage remote sensing program to assess reindeer rangeland. in Sondheim, M.W. and P.M. Daykin, ed., Proc. Ecol. Data Processing & Interpret. Workshop. B.C. Min. Environ., Terr. Stud. Br.: 345-352.

Summary of remote sensing approach to studying the reindeer range east of the Mackenzie Delta, mainly on the Tuktoyaktuk Peninsula. Data gathering involves several levels: Stage I - analysis of LANDSAT scences, digitally and by photo-interpretation; Stage II - study of intermediate level black and white and colour air-photos; Stage III - photo-interpretation and detailed mapping of large-scale 70 mm photos; and ground-truthing summer field work to delineate major vegetational groupings, obtain lichen biomass estimates and collect information on soils and general site.

Expected results are indicated: "Data gathering is presently ongoing and a second field program is planned for ground-truthing and monitoring first year changes after grazing in selected areas. After photo and image interpretation, the multistage approach will be used to knit together information acquired at the various scales. Ultimately, it is hoped the scheme will provide a basis for future management of the reindeer and the rangeland."

Keywords: rangeland - general, remote sensing

Stager, J.K. 1956. Progress report on the analysis of the characteristics and distribution of pingos east of the Mackenzie Delta. Can. Geogr. 7:13-20.

Following examinations of pingos on the Tuktoyaktuk Peninsula, Mackenzie Delta and Eskimo Lakes area on 1;40,000 air photos, pingo distribution was plotted on a base map and characteristics of pingos were noted, including size, shape, plan outline, summit character, patterned ground, location and immediate environment. A total of 1380 pingos were identified, and isopleths based on densities per ten sq. mi (26 sq km) were mapped, so that three main areas of concentration could be identified: 1) along the East Channel of the Mackenzie River between Tunuuk and Kittigazuit, 2) the area from Toker Point to Tuktoyaktuk and further west, and 3) the west side of Richards Island.

Keywords: permafrost - pingos

Stager, J.K. and K.G. Denike. 1972. Reindeer herding in the Mackenzie Delta region: A social and economic study of a northern resource industry. Dept. Geography, Univ. British Columbia. Unpubl. Rep. 207 pp.

A comprehensive report on social and economic aspects of the Mackenzie Delta's reindeer industry based on review of government records on the operation, interviews with selected individuals who for various reasons were qualified to provide both facts and opinions about the reindeer project, and field observations by the authors during fawning period and at fall roundup.

A historical survey of the reindeer operation is provided, including background to the 1929 purchase of reindeer in Alaska and the initiation of the project in 1935. Immediate objectives in 1935 were to obtain experienced management - Laplanders - to set up the operation, draw in local Eskimo men through an apprenticeship program, and build up herd numbers. Although the first few years appeared successful outwardly, problems arose with recruiting native people for the work. In 1938, the first native herd was established near the Anderson River, and a second began in 1940. Both achieved some success but the herders and most of their families were killed in a schooner accident in 1944, and the herds were rejoined with the original one. Other attempts to begin separate native herds, in 1948, 1950, 1952 and 1954 were abandoned within a few years, usually with much reduced numbers of animals and in one case with severe health problems of hoof rot and "broken back disease". Main problems with the herds were the difficulties of close-herding on assigned ranges, lack of suitable forages, personnel conflicts and low morales, straying and predation, and in some instances, insufficient cash generated.

Growth and development of the main herd seemed initially favourable, however, expenses increased disproportionately and a host of problems, both human and biological surfaced. Recommendations were made on herding strategies, herd population and structure, predation control, foot-rot control, diet deficiencies, cross-breeding of straying reindeer with caribou infiltrating the region from the east, etc.

A review of the operation by J.J. Teal Jr. in 1959 led to a careful rethinking of the implications of the transplant of the Lappish closeherding, 24 hour watch type of herding and the possibility that another more extensive strategy, using aircraft herding, selective breeding, etc., could be used. The government favoured the letting of a contract on the operation in late 1959 until 1967 when it was suddenly realized that while estimates of the population were around 10,000, aerial surveys only counted 2756 animals. Contract operation was curtailed and Canadian Wildlife Service performed a holding operation for a five-year period until April 1973.

The incongruencies of the Eskimo culture to the operation of the reindeer project are discussed. A review of literature concerning Eskimo herd ownership in Alaska shows the many difficulties to be encountered in introducing this new way of life.

Economics of the reindeer industry are considered in detail. A forecast for herd growth with continuing slaughters, and selective breeding suggests modest increases yearly up to about 10,000 animals by 1975. Markets and potential markets are examined including aspects of transportation, pricing, etc. and guidelines are set up for a "low-overhead

operation", or alternatively an "intensive management operation". A detailed summary makes the recommendation to turn the herd over to native control, partly as a response to local attitudes towards the herd, and also because the herd is in a position to become economically viable as a local industry. The strategies for disposal of the herd by the government are considered: a) the herd should be sold to a local individual of native origin, b) the herd should be sold to the Hamlet of Tuktoyaktuk, c) the federal government should retain the reindeer herd and continue its management to hold the number of animals at approximately the current level for another two years, d) a white buyer in the N.W.T. should be found, e) an acceptable owner/manager elsewhere in Canada be found, f) the federal government continues to run the herd, g) a liquidation plan be devised, h) a privately-managed game farm be considered, i) a local co-operative be organized for meat production. Recommendations for implementing either of the first two strategies are detailed.

Keywords: historical notes - general operation, reindeer products and markets, herd population dynamics, diseases and parasites, rangeland - general

Steere, W.C. 1958. Bryophytes of Arctic America. VII. A collection from the Delta region of the Mackenzie River. The Bryologist 61:182-190.

Hepatic and moss collections by W.J. Cody in 1957 are listed with locational and habitat information. The author indicates that the presence of wholly unexpected species and the absence of many cosmopoliton and weedy species in the collection suggests that careful bryological research in the area would be rewarding and the moss flora is likely very rich.

Keywords: floristic notes - mosses, phytogeography

Strang, R.M. 1973. Studies of the vegetation, landform and permafrost in the Mackenzie Valley: some case histories of disturbance. Environmental-Social Program, Northern Pipelines. Report No. 73-14. 49 pp. + appendices (8 fold-out tables).

A study of the effects of disturbance on a wide range of site-types in the Mackenzie Valley, including examples from the Inuvik-Tuktoyaktuk region. The two most common causes of serious damage were the exposure of subsurface ice or frozen soil on sloping ground and the intersection and diversion of drainage channels. Tabular summaries for 200 field sites, including sites from the Inuvik area (table 8), that provide information on locations, natural plant community, soil type and depth, tree diameter, height and age, the type of disturbance and the elapsed time since it occurred, and a description of the ground cover, slope and soil depths of the adjacent disturbed community.

Keywords: terrain disturbance, vegetation - ecology, soils, permafrost - general

Tarnocai, C. and J. Thie. 1974. Permafrost and remote sensing. Proc. 2nd Can. Symp. Rem. Sens.:438-447.

To evaluate different remote sensing techniques and imagery for mapping and describing permafrost phenomena, four study areas in northern Canada were selected including one from the Inuvik area, N.W.T. The potential usefulness of LANDSAT in northern Canada is discussed, including permafrost typing, and the use of temporal satellite data for study of melting, river breakup and dynamics, and forest fire detection and mapping.

Keywords: permafrost - general, remote sensing, vegetation - mapping (regional)

Tarnocai, C. and S.J. Kristof. 1976. Computer-aided classification of land and water bodies using LANDSAT data, Mackenzie Delta area, N.W.T., Canada. Artic and Alp. Res. 8(2):151-159.

A digital classification was carried out on a LANDSAT subscence of the Richards Island area, Mackenzie Delta, and 22 spectral classes (14 terrestrial and 8 aquatic) were generated that represented 10 cover-types: (1) very wet marsh, (2) wet marsh, (3) marsh, (4) peatland, (5) other small wetlands along lakeshores and peatlands, (6) shallow lakes or ponds, (7) uplands, (8) unvegetated shoreline, sandbars, shallow water, (9) partly vegetated shoreline, drained lakebeds, (10) river channels, lakes, lagoons and bays. A subsequent comparison of a computer-generated map of the 10 cover-type classes to ground-truth studies at selected sites suggested a maximum overall classsification accuracy of 88%.

Keywords: permafrost - general, remote sensing, vegetation - mapping (regional), vegetation - classification

Taylor, G. 1945. Arctic survey III. Mackenzie domesday: 1944. Can. J. Econom. & Polit. Sci. 11:189-233.

Narrative of travels by the author from McMurray and Waterways to the mouth of the Mackenzie River in summer 1944. Includes a brief introduction that describes the general physiography, climate and vegetation. Text includes descriptions on the Delta environment, the modern history and ground-plans of the townsites of Aklavik, Reindeer Depot and Tuktuk (Tuktoyaktuk), and other general observations. Brief mention only of the reindeer herd, including an account of the drive from Alaska, and the grazing plan at that time of closed-herding with summer range on Richards Island and mainland winter grazing near the Caribou Hills.

Keywords: historical notes - general operation

Tomassini, F.D., K.J. Puckett, E. Nieboer, D.H.S. Richardson and B. Grace. 1976. Determination of copper, iron, nickel and sulphur by x-ray

fluorescence in lichens from the Mackenzie Valley, Northwest Territories, and the Sudbury District, Ontario. Can. J. Bot. 54(14):1591-1603.

Tundra lichen species from N.W.T. locations, including near Inuvik and Tuktoyaktuk, and from Sudbury District, Ontario were elementally analyzed using an x-ray flourescence technqiue. Levels of copper, iron, nickel and sulphur in Arctic lichens were similar to those found in lichens growing on the edge of Sudbury's pollution zone but much lower than in specimens nearer the Sudbury smelter.

Keywords: floristic notes - lichens, vegetation - fertility/chemistry

Treude, E. 1968. The development of reindeer husbandry in Canada. Polar Rec. 14(88):15-19.

A brief review of early attempts to establish a Canadian reindeer industry, and an account of the early history of the Mackenzie Delta herd in the 1930's and 1940's. Early attempts to establish native-owned herds

failed for a variety of reasons, insufficient herding, over-exploitation of the herds, overgrazing near the settlements, losses through disease, predation and poaching, and the overriding difficulty of attempting to make responsible herders out of traditional hunters. While the only clear result of the experiment was that herded reindeer can live and multiply in northern Canada, the author notes that the social importance ought not to be misjudged or underrated; during the first few decades, the herd supplied considerable amounts of meat for local consumption.

". . . in 1958, it was obvious that the experiment was no longer viable in its existing form. The government had three possible courses of action: to abandon the herds altogether, to increase government supervision and involvement, or to transfer management to experienced private interests to see if they could achieve economic success."

Keywords: rangeland - general, historical notes - general operation, herd population dynamics, reindeer products and markets

Treude, E. 1979. Forty years of reindeer herding in the Mackenzie Delta, N.W.T. Polar Geogr. 3(3):121-138. [originally published, 1975 in Polarforschung 45(2):129-148].

"Reindeer herding in the Mackenzie Delta area started in March 1935, when a herd of 2,370 animals was delivered to the newly established Reindeer Grazing Preserve. Conceived to supplement the dwindling wildlife resources of the Canadian Arctic and to improve the economic conditions of the native Eskimos, the policy was to keep a government-owned nucleus herd from which additional units could be obtained and put under Eskimo management. Several native-owned herds were set up, but for various reasons they all were returned to the government, the last one in 1964. A new approach was undertaken in 1960; in an attempt to demonstrate the economic feasibility of an Arctic reindeer industry, the project was placed under private management. There were plans to start large-scale reindeer

breeding following modern conceptions of reindeer husbandry, but when the reindeer population dropped alarmingly, the Canadian Wildlife Service in 1968 accepted the responsibility for a five-year term. The main task then was to rebuild the herd and to conduct biological as well as managementrelated studies. In March 1974, the herd was finally sold to a native-owned Reindeer Company. In addition to providing a detailed review of reindeer herding in the Mackenzie Delta area, an attempt is made to evaluate the past economic importance of the project and to assess its potential future development".

The author notes the future of reindeer herding in the Mackenzie Delta will be determined by three factors: "the potential carrying capacity of the available grazings; the absorption capacity of the (economic) market; and the number of agressive people within the personnel of the Reindeer Company Limited." A theoretical grazing intensity of 0.6 reindeer per km^2 (30,000 reindeer) for the entire Preserve compares closely with a value of 0.7 reindeer per km^2 determined for the Soviet Union. However, intensified encroachment by expanding stocks of caribou prevents, or at least complicates the inclusion of the eastern half of the Preserve in controlled patterns of grazing. Richards Island, as well, is largely unavailable as summer range because of severe past overgrazing and a human presence with oil and gas exploration activities. In view of these restrictions, the author states "it is absolutely essential that the potential carrying capacity be determined anew."

Keywords: reindeer rangeland - general, reindeer rangeland - carrying capacity, historical notes - general operation, herd population dynamics, overgrazing, reindeer products and markets.

Wein, R.W. 1975. Vegetation recovery in arctic tundra and forest-tundra after fire. Environmental-Social Program, Northern Pipelines. Report No. 74-75-62. 115 pp.

Study conducted 1973-74 to determine the recovery rate of burned areas in the northern part of the boreal forest and in tundra. Intensive investigations were conducted on the 350 km^2 burn NE of Inuvik that occurred in August, 1968. A map shows locations of small and large fires in the Inuvik-Tuktoyaktuk region, and frequency and distribution of fires in the area is discussed. Other study results include plant succession patterns after fire, tree seed sources and tree re-establishment, small mammal repopulation after fire, soil stability and vehicle disturbance on burned tundra.

Keywords: wildfire, vegetation - ecology, vegetation - producitvity, permafrost - general, terrain disturbance

Wein, R.W. 1976. Frequency and characteristics of arctic tundra fires. Arctic 29(4):213-222.

"Characteristics of over 50 tundra fires, located primarily in the western Arctic, are summarized. In general, only recent records were available and the numbers of fires were closely related to the accessibility of the area. Most of them covered areas of less than one square kilometre (in contrast to forest fires which are frequently larger) but three tundra fires on the Seward Peninsula of Alaska burned, in aggregate, 16,000 square kilometres of cottongrass tussocks. Though tundra fires can occur as early as May, most of them break out in July and early August. Biomass decreases, and so fires are more easily stopped by discontinuities in vegetation, with distance northward."

Eighteen fires are noted for the tundra east of the Mackenzie River Delta, and man ignited ten of the twelve fires of known cause. While most fires burn small areas, increased human activity in the north will increase the frequency of fire.

Keywords: wildfire, terrain disturbance

Wein, R.W. and L.C. Bliss. 1973. Changes in arctic Eriophorum tussock communities following fire. Ecology 54:845-852.

Two of the four study areas were located in the Reindeer Preserve, one 24 km N of Inuvik near the Caribou Hills (cottongrass tussock tundra), the second near the Inuvik townsite (cottongrass tussock with scattered spruce).

"The arctic cottongrass (Eriophorum vaginatum ssp. spissum) tussock community is susceptible to fire even though it has a relatively small aboveground standing crop and the peaty substrate is wet even in years of low precipitation. While burns can be severe enough to kill all above-ground plant parts, differential protection is provided new shoots by tussocks bases, moss mats, and peat. Plant succession following fire was unique in that no new species invaded the area. Growth came principally from root stocks protected by the organic surface. Cottongrass and Carex spp. were the first to show regrowth following a June fire at one site. The role of cottongrass seedlings in colonizing these tussock communities was minor, because few seedlings older than 1 year were found on any of the sites. Epilobium angustifolium ssp. angustifolium and some Calamagrostis canadensis ssp. canadensis originated from seed although most plants of the latter species had long vigorous rootstocks. These plants occurred as minor components in the undisturbed community and increased when fire destroyed the competing species. The charred organic surface, being very dark, absorbed more short wave energy and the active layer depth increased by 35 to 50% in June and as much as 25% by late autumn. The same thermal regime was found in burns several years old. This warmer soil mass, over a longer period of time, was conducive to better growing conditions. Annual plant production had almost recovered after two growing seasons, and nutrient content of the plants was higher in the burned area. This may be due to the greater soil mass available for root exploration, to nutrient release by fire, and to greater microbial activity in the warmer soils. If other tundra communities respond to fire in a similar manner as cottongrass tussock communities, fires may act as a rejuvenating factor, as they do in other biomes."

Keywords: wildfire, vegetation - ecology, soils, microclimate

Wolforth, J. 1965. The Mackenzie Delta - its economic base and development - a preliminary study. North Co-ord. and Res. Centre, Dept. Indian Aff. and North. Develop., Ottawa. 85 pp.

Past operation and the economic potential of the reindeer herding experiment is considered in some detail (pp. 17-27). Problems associated with the operation are considered including the difficulty of establishing native-owned herds, the high losses due to straying and predation, and the need for expanded future markets for meat, particularily outside of the N.W.T.

Keywords: historical notes - general operation, reindeer products and markets, herd population dynamics.

Wolforth, J.R. 1970. "Dual allegiance" in the Mackenzie Delta, N.W.T. - aspects of the evolution and contemporary spatial structure of a northern community. Unpubl. Ph.D. thesis, Dept. of Geography, Univ. of British Columbia. 422 pp.

Brief mention of Reindeer Station in connection with the "settlement-forming process" in the north (pp. 198-199). Established in 1932, the particular site chosen was close to both winter and summer ranges, had a good supply of timber both for building and for fuel, was closer to Aklavik than previous temporary headquarters at Kittigaziut, and had a source of potable water. Reindeer Station consisted only of the homes of the administrator and the families of the herders, since the herders themselves lived close to the herd on the Reindeer Reserve for much of the year. In 1949 the Hudson's Bay Company opened a store at Reindeer Station, after which the settlement took on limited functions as a service centre for the eastern part of the Delta until Inuvik was established in the mid-60's.

Keywords: historical notes - general operation, human geography

Younkin, W. 1973. Autecological studies of native species potentially useful for revegetation, Tuktoyaktuk region, N.W.T. in Bliss, L.C. (ed.) Botanical studies of disturbed sites in sub-arctic and arctic regions. Environmental-Social Program, Northern Pipelines. Report No. 73-43:45-76.

"Two arctic grasses, Arctagrostis latifolia var. latifolia and Calamagrostis canadensis ssp. canadensis observed to be naturally recolonizing disturbed areas on the Tuktoyaktuk Peninsula, were studied to determine their potential for use in an accelerated revegetation program". Although these two grasses produce smaller amounts of seed relative to other species of undisturbed tundra 1) the seed produced is highly viable and grows readily in the moist organic mats of disturbed tundra, and 2) the seedlings overwinter well, and by the second season produce numerous flowering shoots and 3) laboratory studies of root and shoot response to cold soils suggest that, of the two species, Arctagrostis is the better adapted to the permafrost environment. Studies of microenvironmental

differences between undisturbed and disturbed tundra are also summarized and related to the seedbed conditions of disturbed sites.

Keywords: vegetation - ecology, terrain disturbance, floristic notes - vascular plants

Zoltai, S.C. 1976. Voyageur air cushion vehicle trials on the Mackenzie Delta: environmental effects two years later. Environ. Can., Can. For. Serv., North. For. Res. Cent. Edmonton, Alberta. Inf. Rep. NOR-X-146. 23 pp.

"Tests were conducted in 1973 with a prototype Voyageur air cushion vehicle on the Mackenzie Delta in lowland and upland tundra conditions. Reassessment in 1975 showed no damage or change in the vegetation or in the thawed layer on the lowland tundra trial courses. On the upland tundra some vegetation damage was recorded and the organic mat was torn in a few instances. Thawed layer thickness on the trial courses increased by 20-25%, probably the result of reduced albedo. The increased thawing did not lead to terrain subsidence."

Keywords: terrain disturbance

Zoltai, S.C. and C. Tarnocai. 1974. Soils and vegetation of hummocky terrain. Environmental-Social Program, Northern Pipelines. Report No. 74-75. 86 pp.

Studies on the widespread hummocky features of the northern Mackenzie Valley area, including morphology, soil moisture contents and temperature profiles, soils classification types, soil textures, radiocarbon aging of organic deposits, and general surface vegetation. Hummocky terrain, it is concluded, is vulnerable to disturbances that disrupt its insulating abilities. The natural surface is highly mobile so that structures placed on it will be subject to such movements.

Keywords: soils, vegetation - ecology, terrain disturbance, permafrost - general

Zoltai, S.C. and C. Tarnocai. 1975. Perennially frozen peatlands in the western arctic and subarctic of Canada. Can. J. Earth Sci. 12(1):28-43.

Morphological descriptions of frozen peatland types, including low and high center polygons from the Tuktoyaktuk Peninsula. Data includes cross-sections of polygons, moisture content, active layer thickness and peat thickness measurements and carbon-dating of surface and basal peats. It is concluded that the peat in lowland polygons accumulated under permafrost conditions.

Keywords: soils, vegetation - ecology, permafrost - general

5. Subject Keyword Index

A/ HISTORICAL NOTES

Planning for Herd

Kelly 1932; Kitto 1930; Porsild 1929; Rutherford et al. 1922; Scotter 1970a

Trek from Alaska

Anon 1982a; Evans 1933; Kelly 1932; Lomen 1954; McMillion 1939; Miller 1935; Porsild 1971; Scotter 1966, 1967, 1972c, 1978

Establishment of Herd

Crerar and Bonnycastle 1936; Porsild 1936

General Operation

Abrahamson 1963, Anon 1949, 1982a; Clarke 1942; Hadwen 1939; Hill 1967; Krebs 1959; Porsild 1947, 1954; Rea 1968; Scotter 1968; Stager and Denike 1972; Taylor 1945; Treude 1968, 1979; Wolforth 1965, 1970.

B/ RANGELAND

General

Anon 1982a; Blaylock 1980; Canada Dept. Environment 1973; Clarke 1942; Cody 1963; Dickinson 1982; Friesen and Nelson 1978; Hadwen 1939; Hill 1967, 1968; Inglis 1971, 1975b; Johansson 1964; Johnston and Smoliak 1979; Klein 1970, 1980; Nasogaluak and Billingsley 1981; Porsild 1929, 1936, 1942, 1947, 1954; Rutherford et al. 1922; Scotter 1968, 1970a, 1970b, 1972a; Scotter and Telfer 1976; Sims and Murtha 1981; Stager and Denike 1972; Treude 1968, 1979.

Carrying Capacity

Hadwen 1939; Hill 1967; Porsild 1929, 1947, 1954; Scotter 1968, 1970a, 1970b, 1972a; Treude 1979.

Rotational Use

Cody 1963; Inglis 1975a; Johansson 1964; Porsild 1929, 1942, 1947.

Overgrazing

Cody 1963, 1965a; Hill 1967; Inglis 1971, 1975a, 1975b; Porsild 1947, Scotter 1968, 1970a, 1970b, 1972a; Treude 1979.

C/ HERD

Fawn Growth and Development

Hill, 1967; Krebs 1959, 1961, 1962; Nowosad 1970, 1972, 1974

Herd Population Dynamics

Abrahamson, 1963; Anon 1949, 1982a; Clarke 1942; Hadwen 1939; Hill 1967; Krebs 1959, 1961, 1962; Nasogaluak and Billingsley 1981; Nowosad 1970, 1972, 1974; Porsild 1947; Scotter 1968; Stager and Denike 1972; Treude 1968, 1979; Wolforth 1965

Disease and Parasites

Cody 1963; Hadwen 1939; Hill 1967; Klein 1980; Stager and Denike 1972

Reindeer Products and Markets

Abrahamson 1963; Anon 1949, 1982a,b; Clarke 1942; Friesen and Nelson 1978; Hill 1967, 1968; Nasogaluak and Billingsley 1981; Scotter and Telfer 1976; Stager and Denike 1972; Treude 1968, 1979; Wolforth 1965

Carbou/Reindeer Conflicts

Anon 1982b; Blaylock 1980; Canada Dept. Environment 1973; Canada Dept. Indian and Northern Affairs 1976; Hawley 1970; Hill 1967; Kevan 1971; Klein 1970, 1980; Porsild 1942; Scotter 1968, 1970a, 1970b, 1972a; Scotter and Telfer 1976

D/ EARTH SCIENCES

Bedrock Geology

Mackay 1963

Surficial Geology

Canada Dept. Energy, Mines & Resources 1972; Kerfoot 1969; Mackay 1963; Rampton 1972; Rampton and Mackay 1971; Rampton and Bouchard 1975

Permafrost - general

Anon 1974; Canada Dept. Energy, Mines & Resources 1972; Crampton 1977; Gill 1971; Kerfoot 1969, 1972; Strang 1973; Tarnocai and Thie 1974; Tarnocai and Kristof 1976; Wein 1975; Zoltai and Tarnocai 1974, 1975

Permafrost - ground ice

Mackay 1963, 1970; Rampton and Mackay 1971; Rampton and Bouchard 1975

Permafrost - pingos

Ito 1978; Mackay 1963, 1979; Porsild 1938; Stager 1956

Physical Geography

Anon 1974; Canada Dept. Energy, Mines & Resources 1972; Gill 1971; Lambert 1972; Mackay 1963; Porsild 1929, 1938; Rampton 1972; Sayn-Wittgenstein 1973

Soils

Anon 1974; Crampton 1977; Gill 1971; Haag 1973, 1974; Haag and Bliss 1974; Hernandez 1973; Hutchinson and Freedman 1976; Hutchinson et al. 1976; Janz 1973; Kerfoot 1969, 1972; Mackay 1963, 1970; Strang 1973; Wein and Bliss 1973; Zoltai and Tarnocai 1974, 1975

E/ VEGETATION

Mapping (regional)

Canada Dept. Environment 1974a, 1974b, 1975; Hernandez 1974; Mackay 1963; Sayn-Wittgenstein 1973; Tarnocai and Thie 1974; Tarnocai and Kristof 1976

Mapping (large scale)

Anon 1974; Gill 1971; Kerfoot 1969

Classification

Black and Bliss 1978; Canada Dept. Environment 1974a,1974b, 1975; Corns 1974; Gill 1971; Hernandez 1974; Inglis 1971, 1975a; Ito 1978; Kerfoot 1969; Lambert 1972; Porsild 1929; Ritchie 1974; Scotter 1968; Tarnocai and Kristof 1976

Ecology

Anon 1974; Black and Bliss 1978; Cody 1963, 1965a, 1965b; Corns 1974; Gill 1971; Hernandez 1973; Hutchinson and Freedman 1976; Hutchinson et al. 1976; Inglis 1975a, 1975b; Ito 1978; Lambert 1972; Porsild 1943, 1947; Porsild and Cody 1980; Strang 1973; Wein 1975; Wein and Bliss 1973; Younkin 1973; Zoltai and Tarnocai 1974, 1975

Fertility/Chemistry

Haag 1974; Janz 1973; Scotter 1968, 1972b; Scotter and Miltimore 1973; Tomassini et al. 1976

Productivity

Ito 1978; Janz 1973; Scotter 1968; Wein 1975

Energy Budget

Freedman and Hutchinson 1976; Haag 1973, 1974; Haag and Bliss 1974; Hutchinson et al.1976

Palynology

Ritchie 1974; Ritchie and Hare 1971

Phytogeography

Ahti et al. 1973; Cody 1965a, 1965b, 1979; Holmen and Scotter 1971; Hulten 1968; Porsild 1943, 1957; Porsild and Cody 1980; Steere 1958

Floristic Notes - general

Gill 1971; Hernandez 1973; Inglis 1975a; Kerfoot 1969; Ritchie 1976; Scotter 1968

Floristic Notes - vascular plants

Black and Bliss 1978; Cody 1963, 1965a, 1965b, 1979; Corns 1974; Hulten 1968; Porsild 1943, 1957; Porsild and Cody 1980; Younkin 1973

Florsitic Notes - mosses

Holmen and Scotter 1971; Steere 1958

Floristic Notes - lichens

Ahti et al.1973; Black and Bliss 1978; Tomassini et al. 1976

F/ OTHER FEATURES

Wildfire

Black and Bliss 1978; Canada Dept. Environment 1974b; Haag 1973; Hernandez 1974; Mackay 1970; Wein 1975, 1976; Wein abd Bliss 1973

Terrain Disturbance

Canada Dept. Energy, Mines & Resources 1972; Crampton 1977; Freedman and Hutchinson 1976; Haag 1973; Haag and Bliss 1974; Hernandez 1973, 1974; Hutchinson and Freedman 1976; Hutchinson et al.1976; Kerfoot 1969, 1972; Mackay 1963, 1970; Nowosad 1972; Radforth 1973; Rampton and Mackay 1971; Rampton and Bouchard 1975; Ritchie 1976; Strang 1973; Wein 1975, 1976; Younkin 1973; Zoltai 1976; Zoltai and Tarnocai 1974

Human Geography

Mackay 1963; Wolforth 1970

Sensitive Sites

Canada Dept. Energy, Mines & Resources 1972; Canada Dept. Indian and Northern Affairs 1976; Cody 1963; Gill 1971; Kerfoot 1972; Revel 1978; Ritchie 1976

Remote Sensing

Dickinson 1982; Sayn-Wittgenstein 1973; Sims and Murtha 1981; Tarnocai and Thie 1974; Tarnocai and Kristof 1976

Alternative Land Use

Canada Dept. Indian & Northern Affairs 1976

Macroclimate

Burns 1973; Ritchie and Hare 1971

Microclimate

Freedman and Hutchinson 1976; Gill 1971; Haag 1973, 1974; Haag and Bliss 1974; Hernandez 1973; Mackay 1970; Wein and Bliss 1973.

Wildlife

Canada Dept. Environment 1973; Cody 1963; Friesen and Nelson 1978; Porsild 1942